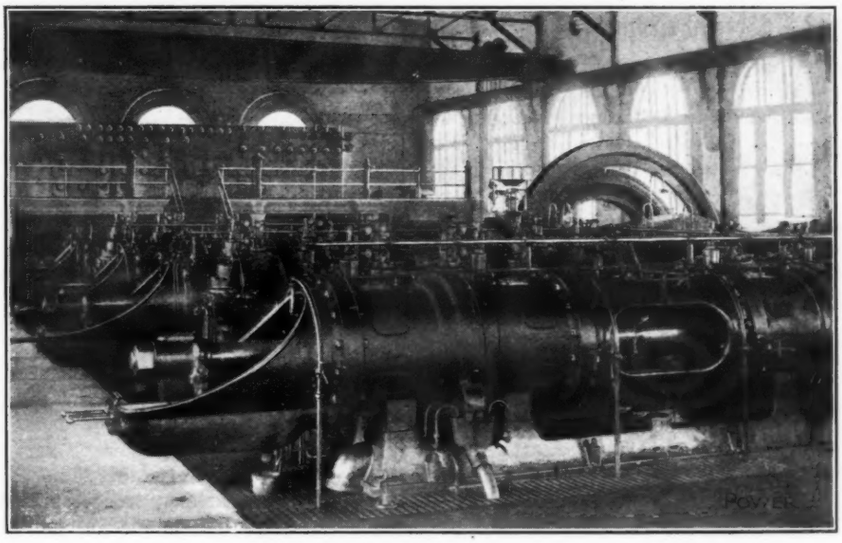
PUBLIC LIBRARY
No. 605.P54 (1)
DETROIT, MICH.

POWER

Vol. 36 NEW YORK, AUGUST 20, 1912 No. 8

WHEN gas engines first entered the power field it was assumed that good men could be obtained to operate them for about $1.25 per day, that is, start and stop them and keep them lubricated during the working period.

If anything went wrong a machinist was called in to make repairs, no matter whether he understood gas engines or not. He received 60 cents an hour for his work, and often worked two or three days trying to make an engine run, when the only trouble was that the exhaust ports were almost closed with a carbon deposit.



Steam engineers are not gas engineers. They are in separate fields and both must be trained in their respective callings. When a steam engine goes wrong the cause is usually apparent to a steam engineer; when a gas engine refuses to operate, it requires a man well versed in its operation to overcome the difficulty without undue loss of time.

Engineers who can successfully handle gas engines and may be looking for a larger opportunity than seems to be theirs, so far, may well turn their attention to the oil region of Kansas, Oklahoma, Texas and other oil producing states where the gas engine is largely used for field work. Competent men to take charge of repairs are not plentiful and a capable man would find renumerative employment superintending such work.

The old idea that anybody can run a gas engine plant still obtains in the minds of some owners and managers. The engines are run with cheap help until they demand attention when a competent engineer is engaged to put the plant in good running order. Even then the old method of operation is sometimes resumed, an excuse being given for letting the high-grade engineer go.

But this class of owners is disappearing and more and more are operators of real ability being sought. Not cheap help, but economical operation is the motto. Why not be a gas engineer and get in line to accept some of these positions when they appear?

Several engineers have become specialists in superintending the repairing of gas engines, but they studied hard and obtained practical experience before they were competent to undertake the work. There is room for others in this same field and the necessary knowledge can be gained in the same way.

Do not confuse the modern gas engine with the wood-sawing outfit. There are gas power plants in operation that can put thousands of steam plants in the shade for size, and they require good men to operate them. Capable men who understand their business should have no trouble in making good in the gas engine field.

Running a Steam Turbine

By F. R. Brosius

This, in the opinion of the judges, is the second best of the 46 articles submitted in the contest for the 50-Dollar prize. A symposium of the subject made up of the salient points of the other contributions will appear in another issue.

The same general principles apply to operating turbines as to engines, the turbine, however, is the more easily handled. There are numerous bothersome things to contend with in the turbine, but its operation is very much simpler than that of the engine. Doubtless, a large proportion of the earlier troubles were such as are common to all radical departures from existing practice, but these were gradually overcome as undesirable features were eliminated and experience in operation was gained. How far this was true depended upon the engineer himself. It was his task to master the intricacies and finer points of operation.

Starting a turbine, preparatory to cutting it in on the line, is purely mechanical and routine work. Consequently, the following deals more with those things which would tend to interrupt a turbine's service, and to find the remedies to be applied. The writer's experience has been altogether with high-pressure turbines, and since most turbines in use are of this type, and the repair and operation of the low-pressure type is so like that of the high pressure, only the operation of the latter will be described.

Placing the Turbine in Service

1. Turn steam, or water, as the case may be, into the packing seals. This will prevent leakage of air which would tend to lower the vacuum.

2. Start the air pump—get it up to speed.

3. Start the step-bearing pumps and get the pressure up to normal.

4. After the air pump has run long enough to free the circulating pump and its suction pipe of air, and the condenser is primed, start the circulating pump and get it up to speed.

5. Start the oil pumps and have oil circulating freely to all bearings. Oil all parts that have to be oiled by hand. See that the oil pressure is up to that required for your particular installation, as different sized turbines require different pressures on the step, while, with the horizontal turbine, the oil pressure on the relays for operating the governor is different from that required for the bearings.

6. Start the turbine turning around slowly until thoroughly warmed up. When up to speed, note particularly if the governor controls the turbine; if so, open the throttle.

7. The turbine is now ready to be cut in on the line.

Note: In case the dry-vacuum system is used, start the hot-well pump before the air pump, to remove any condensation which may be in the condenser.

Taking the Turbine Out of Service

1. Gradually remove the load. See if the governor controls the turbine; then shut down by using the emergency trip, to keep the trip in perfect working order.

2. Shut off the steam (or water) from the packing seals.

3. Shut down the condenser pumps.

4. Shut down the oil pumps after turbine has stopped.

Note: In the case of a vertical turbine, do not close down the step pumps until the turbine has stopped.

Only within the last ten years has the steam turbine come into prominence as a prime mover. It has proved its great economy in floor space, steam consumption, first cost, repair costs, and attendance, in the great modern power plants. Now it is demonstrating its value as a prime mover in the very small plant. Therefore, it behooves the engineer to know something about the turbine.

It is only a question of time until the engineer in the present reciprocating-engine plant will be called upon to advise his employers as to the saving or advantage to be effected by installing turbines. He must be prepared to furnish the figures, and still more important, he must have the requisite knowledge to manage and operate the turbine, if he expects to hold his job. Not only for this reason must he keep up with the times, but also as a matter of pride in his profession.

Books without number have been published setting forth the principles of the turbine, describing its mechanical construction in every detail, the why and wherefore of the adoption of various devices tending to simplify and make safer its operation, going into great detail concerning differences in type, giving efficiencies and preferences, etc. In fact, the engineer ought never to be at a loss for proof of any theory about, or principle of, the steam turbine. All this information is easily procured and is a matter simply of reading, while the actual operating troubles are a matter of experience. Remedies must be applied, and those sometimes at a moment's notice. Provision must be made against their repetition. Each emergency becomes a problem to be mastered.

The turbine is yet far from perfect, and will never be so nearly perfect that it will not need attention and adjustment to operate at the highest efficiency. Information regarding turbine troubles has been hard to get. The manufacturers are familiar with turbine failings, but do not like to admit that their machines are not capable of perfect operation at all times. In view of this, we believe that the engineer who makes the greatest success in operating the turbine will be the one who knows the troubles likely to be met, and who knows how to overcome them.

Causes and Seats of Turbine Troubles

Vertical Type

1. Step bearing—injury to buckets.
2. Top-middle-bottom bearings — injury to buckets.
3. Valves—mechanically and hydraulically operated.
4. Valves—electrically operated.
5. Carbon packing rings.

Horizontal Type

6. Water seals.
7. Loss of blading.

Common to Both Types

8. Lubrication.
9. Rapid starting.
10. Cooling the generator.
11. Cleaning the generator.
12. Water in the steam.
13. Magnetic balance.
14. Assembling after repairs.
15. Poor mechanical adjustment.

Prevention and Cure for Turbine Troubles

1. *Step Bearing*—The pump should be kept in very best repair, as a loss of pressure means injury to buckets on both the rotor and intermediates.

The gage indicating the pressure carried must be kept correct.

If water is used on the step, it must be kept free from sediment.

Many turbine installations include a weighted accumulator to keep the step up in case the water or oil pressure is lost. A cheaper way, and one requiring less room but needing more attention, would be to install an emergency steam pump with a regulator in the line to the steps, set at about 5 lb. lower than the pressure regularly carried. If the pressure is dropped by the other pumps, the emergency pump at once picks it up. The steam end of the pump must be kept drained and the pump should be tried at intervals to see that it is working properly, by dropping the pressure on the regular pumps.

A baffle screw in the line to the steps regulates the variations in pressure due

to the pump pulsations. This must be examined frequently and kept clean. Great care should be taken in packing the step-bearing pumps. The rods and glands should be kept in good condition to prevent packing from getting into the water, which will stop up the baffle screw and prevent pressure from reaching the step. The writer has found it well to use a ring of hydraulic packing in the back end of the stuffing-box and to use a good grade of lubricated flax packing. He has tried metallic packings and found them unsatisfactory.

2. *Bearings*—The top, middle and bottom bearings must be kept in perfect condition and alignment. If not kept perfectly aligned, even if they do not heat, they will wear much faster, and when they become loose, the machine is more likely to vibrate.

If water is used on the step, care should be taken to clean the bottom bearing which is lubricated by the water flowing up around it from the step. If the grooves in this bearing become stopped up, or the flow of water is retarded, the pressure will become excessive, raise the rotor and damage the tops of the buckets on the rotor and the bottoms of the intermediates.

The top and middle bearings must not be flooded with oil as are the bearings in the reciprocating engine. There has been considerable trouble with these bearings throwing oil into the generator, but this can be overcome by fitting felt collars tightly around the shaft above the middle and below the top bearings. These should be watched carefully and when the felt becomes worn it should be renewed. If oil is permitted to soak into the windings, it will in time soften and break down the insulation, which usually means rewinding the entire armature.

3. *Valves—Mechanically and Hydraulically Operated*—These valves must be kept properly adjusted, and must not be allowed to get loose to make possible the breaking of any parts. They should also be kept thoroughly lubricated.

All dogs and moving parts in any way controlled by the governor should be close fitting but yet perfectly free, if the machine is to be well governed. Attention given these parts is similar to that required by the valve-gear on a Corliss engine.

4. *Valves — Electrically Operated* — The needle valves must be watched constantly and kept tight, or the leaking will cause the controlling valve to refuse to either open or close.

The baffle-plates may be broken and become wedged around the controlling valve, causing it to stick.

The solenoid spools may become charred and short-circuited, whereupon they could not control the needle valves, and then the controlling valves would not operate.

5. *Carbon Packing Rings*—The carbon-packing rings must be constantly watched and fitted to the shaft to prevent air leaks at this point, which would lower the vacuum. Much more care must be taken in fitting the rings than is necessary with the average bearing surface or with boxes. They must be scraped carefully to the shaft.

6. *Water Seals*—The present type of horizontal turbine is sealed for vacuum by a thin film of water thrown out against the casing by a small centrifugal pump mounted on the turbine shaft. Turbine manufacturers advise using soft water in these seals, and their experience has proved the wisdom of this. With hard water, the parts will in time become covered with a precipitate which will finally either entirely clog up the openings, or eat away the pump blades, according to the composition of the water used. The writer has known this seal to be entirely filled with lime and magnesia in 30 days, and the operator was at a loss to know what affected the vacuum until the man from the shop arrived. This entails expense for repairs, or loss of economy through low vacuum by air leaks at this point and the loss of the use of the machine while making repairs.

The water seals should be regularly inspected for trouble, which may be more easily prevented than cured.

7. *Loss of Blading*—In the earlier types of turbines—the experimental stage—considerable trouble was caused by the blades pitting from the action of the steam upon them. When pitted they became weakened and broken, and in being thrown out struck and injured others. Poor workmanship in placing the blading was also frequently responsible for this trouble. Then, again, blades may be lost by carelessly leaving a nut, small bolt, washer, etc., in the turbine, after inspection or repairs.

In the horizontal turbine, where the clearance is at the periphery of the wheel, it is very important that the shrouding at the outer end of the blades should be perfectly secured. The writer knows of one instance where the end of a section of shrouding on the last row of the last stage gradually worked loose and began striking the casing. This made it become looser until it bent and struck the blades, tearing out or badly damaging all the blades in that row and the corresponding row of the stator. If this had occurred farther in on the stator, it would have torn all the blading out to the low-pressure end of the machine.

8. *Lubrication*—Next to keeping the blading in perfect condition, proper lubrication is most important. The oil must never be allowed to stop for even a few seconds, because it takes but a moment to burn up the bearings. The bearings are so hard to get at, that rebabbitting, or even scraping them, after burning, involves considerable expense.

Turbine makers generally recommend a certain oil which has been found suitable, according to their experience. It would be well to try this oil at first, but it should be closely watched. It may not meet the local conditions. Sometimes an oil is not uniform from month to month; such an oil will leave a deposit in the tanks and piping and probably cause a loss of oil pressure when least expected.

An alarm signal should be installed in connection with the turbine-oiling system so that instant warning may be given of loss of pressure below a certain point. Oil should be cared for in regard to filtering and cleaning about the same as for an engine.

9. *Rapid Starting*—The turbine can be more quickly made ready and cut into service than the reciprocating engine because of the smaller number of parts, but it is far more important that the turbine be thoroughly warmed up before being brought up to speed than is the case with the engine. The clearance between parts is so very small in the turbine, that unless completely warmed up the blades will be injured, due to the warping from uneven heating. The larger the turbine, the more caution should be taken.

10. *Cooling the Generator*—In the early types of turbines, no provision was made for cooling the generator during heavy load; that is, as far as providing openings and passageways in the generator casing itself is concerned. It was found that the capacity of the earlier turbine-driven units was much greater than the rating indicated, if means could be found to prevent the generator from heating. In very many cases, air drawn from outside the turbine room was forced into the turbine by fans, through a system of piping, thus increasing the rated capacity from 25 to 50 per cent. This is provided for in the later units. Besides the possibility of getting foreign particles or dust into the generator there is one source of danger in this operation. During the cold season, if too much air is drawn from outside, frost may be formed in the air passages; and when melted the water may be drawn into the generator. Means must be provided for properly mixing warm and cold air to prevent formation of frost. The air leaving the generator should always be warmer than that of the room.

11. *Cleaning the Generator*—The generator must be kept thoroughly clean. It must be blown out with air at regular intervals and frequently examined to see if it is free from oil or condensed steam. It is well to have a lamp, wired in with a switch, on a vertical turbine, placed below the generator and above the turbine, so that the generator may be examined at any time for oil or moisture, more especially while operating.

12. *Water in the Steam*—The steam

line should contain a separator near the turbine to catch all water which the steam may contain. The separator must have a trap to eject the water, leaving no chance for it to get into the turbine. Water getting into the turbine will slow it down and lower the frequency.

If from any cause water gets to the blading on the condenser side, it will slow down the machine and likely strip the blades, due to their high velocity. These blades have been torn from the rotor where a jet condenser was used, and water from some cause backed up into the machine.

13. *Magnetic Balance*—On a horizontal turbine the generator should have the proper magnetic balance to prevent wear on the thrust collar. The coupling is designed with room for some wear without damage, but if the thrust collar shows wear, it is advisable to watch it to see that the clearance on the coupling is not all taken up. When this occurs, the magnetic pull will be exerted against the dummies. This will be corrected by the maker when it occurs.

14. *Assembling after Repairs*—When the rotor has been taken out of a horizontal turbine for repairs every row of blades should be thoroughly examined *before assembling* for loose blades or foreign objects lodged in them. The stator should be examined just as closely. After the rotor is replaced and before the top of the casing is put on, the rotor should be turned over by hand. The operator should be familiar with the force required to turn it, or should be perfectly sure that it is free, with no undue friction from any cause. After the rotor is in and the top half of the casing is in place and bolted down, the rotor should be *turned over again by hand* to make certain that the blading has no interference. The same precaution should be observed with a vertical turbine in regard to turning around by hand. It may save serious damage to the buckets.

If the bearings are injured and have to be scraped, one should be very sure that the rotor in a horizontal turbine is centrally located, and that the bottom and top clearance, when the cover is put on, are the same. In the vertical type one must look out for alignment.

15. *Poor Mechanical Adjustment*—More care must be used in assembling and adjusting the working parts of a turbine than is usually the custom with an engine. The reader interested in this article should commit this to memory. The governor and controlling valves must be properly lubricated and cleaned, and must not be allowed to become gummed up. In a horizontal turbine, operated by a single controlling valve, sticking of the valve would mean sudden shutdown. No lost motion should be tolerated. It is assumed that the engineer is enough of a machinist, and enough of a stickler for exactness, to see to it that all turbine repairs are properly made; hence no details regarding this have been covered, for it can be left to his common sense to realize the importance of work well done.

Inspecting the Turbine

Owing to the necessarily fine adjustment of the moving parts of a turbine, it seems imperative that inspections should be made frequently. Troubles may be largely overcome by so doing. The engineer cannot see the inside of his turbines too often. He becomes so thoroughly familiar with all its parts that much time and money may be saved in time of trouble. Minute preparations should always be made for examination, so that it may be done with as little labor as possible. Troubles may be thus avoided which under other circumstances would mean a large expenditure for repairs.

It becomes necessary at times to completely overhaul a turbine. Where this is done for the first time, it is advisable to have an erecting man come from the factory who understands the machine. Later the engineer in charge will become familiar enough with the work to do it properly. Enough experience may be gained by working with the erectors at the time of installing for the engineer, unfamiliar with the turbine, to make the proper inspections and adjustments necessary from time to time.

A most valuable aid to the turbine engineer, is a detailed written record of his findings in these cases. Often facts taken from his record will strengthen the stand he may take with his superiors in regard to alterations or improvements he thinks advisable. This record will also indicate ways to avoid repetition of a certain accident, and will always serve him better than his memory alone.

Fig. 1 shows a repair order found very valuable for such a record, which is issued for every repair job to be done. This gives a detail of the repairs made. The important part of this information is tabulated on the sheet shown in Fig. 2. These repair orders are numbered and kept on file, and if giving more detail than it is wished to put on sheet 2, the repair-order number is put at the end of the notes, and can be referred to for full particulars.

POWER STATION REPAIRS - WORK ORDER No. 419

To F. A. Robinson Date Dec. 21. 1907

Work to be done

Change oil piping #8 Turbine as decided upon

Immediately upon completion of above work, make full detailed report of same in space below, and return to office.

Date Completed Dec. 22 1907

Work Done

½" oil piping was changed to ¾" — this was thought necessary because ½" was not large enough on account of the number of blades.

Put ½" drain from tank to draw off the water carried over from the carbon packing

Use other side for writing if necessary Signed F. A. Robinson

FIG. 1.

F.R. Bigelow

Economical Operation

Since the engineer's success depends upon his ability to operate his machinery at the least expense, as well as to keep things running smoothly, his constant aim should be to keep everything in the best repair consistent with the time and labor at his command. By so doing, accidents and shutdowns will be less probable. The vacuum will be kept at the highest point attainable, and no steam-saving factor in turbine operation is more important than carrying a high vacuum. Innumerable tests have proved that the economy of operation increases as the vacuum increases.

Station No. 1 — TURBINE No. 8 — 1907

DATE	STEAM ADMISSION	BEARINGS	CONDENSER	AIR PUMP	CIRCULATING PUMP	MISCELLANEOUS
Sept. 19	Readjusted 5th valve.	Ground in west valves on west steps bearing pumps.				
20		Broke crosshead east steps pumps - replaced it with new one			Keyed crank.	
22	Took off throttle valve - went over it	Ground in east valves - west steps pumps			Keyed crank + crosshead	
Oct. 11			Condenser cleaned.			Oil pipe going into steps bearing leaks - repaired same. Ground cast on oil pumps.
20	Put new gasket of "Superheat" packing on steam chest - south bank of valves).					Made new pointer for controlling valve of stage valve.
30					Keyed crank + crosshead	
Nov. 8	Turbine ran off with 1400 K.W. Found 4th valve had become loosened + lengthened out, causing the bottom dog to miss. It also held the cam so as not to allow the other valves to close.					
9	Found cam on north bank of valves stuck, which caused it to work with rocker arm + hold valves up.					
10	Examined throttle valve. Found gear shaft binding on bottom bush. Lined up bushes.	Ground in all valves on east steps pumps		Looked at valves - tightened glands on air pump		Packed all valve stems.
17		Packed west steps pumps	Tested for air leaks. Found one small one. Condenser cleaned.	Looked at valves + tightened up stuffing box glands.		Took out carbon packing - found top rings closed up + bottom rings cut badly. Filed tops open. Cleaned bottom rings.
Dec. 8	Had throttle valve out - plugged holes in valve. Put new gasket on bonnet on north bank of valves. Had half of gear case off - was filled up with dirt from the oil. Worm + gear look good.	Packed steam end of both steps pumps. Put oil shield on half of middle bearing.		Took cyl. heads off - made new bushes. Made new mitres. Faced off 6 valves.	Took cyl. heads off - made bushes. Made new mitres. Put new Hayden packing on piston rod. Tightened nuts all over pumps. Repacked shaft.	Put new packing rings on - had to scrape rings to fit, as rings were for larger shaft. Allowed .012" for bottom ring.
22			Tested for air leaks - found none. Condenser cleaned.			Changed ½" oil feed pipe to ¾" - Put ½" drain on bottom of tank. See repair work order No. 419.

FIG. 2. F. R. BRONUS

Time has also proved it advisable to use superheated steam; the temperature depends upon local conditions, there being a place where the saving effected in steam consumption will be over-balanced by the interest on extra capital invested and increased cost of maintenance. Erosion is more likely to occur where saturated steam is used.

The largest power plants of the country have a force of men constantly employed in testing turbines and generating equipment. The results of their tests are used in determining the repairs to be made. The engineer in a small plant would be greatly benefited by tests made upon the apparatus under his control. Knowing what the machinery will do is one of the greatest essentials of turbine operation. For instance, tests will show that at a certain per cent. of a turbine's rated load it will produce a kilowatt with the least steam. The wide-awake engineer will then endeavor to operate his machine at that load as far as plant conditions will allow. Again, with the vertical turbine, the amount of clearance between the nozzles and buckets greatly influences the economy of the turbine. As a result of a series of tests which the writer personally supervised, a saving of 6 per cent. was made by reducing the clearance on a vertical turbine from 0.120 to 0.090 in., while a subsequent test, after reducing the clearance from 0.090 to 0.050 in., showed a further reduction in steam consumption of only 0.2 per cent. In a horizontal turbine the clearance on the dummies should be so adjusted that the balancing pipes will be at a low temperature.

On another occasion, placing a new set of intermediates in the turbine saved 8 per cent. in steam consumption, greatly over-balancing the cost of the new parts.

Nearly every engineer in charge of a power plant has enough time and labor at his bidding, if he only thinks so, to make tests which will give him valuable information as to the condition of his generating equipment. He may have to use a fireman or an oiler to weigh water and possibly work them overtime on such occasions, but he will always find the old adage applies to special work around the station, "Where there is a will there is a way." Maybe he cannot go into the finer points regarding efficiencies, etc., but he can at least obtain the correct steam consumption. As soon as possible after the turbine is erected, he should make his first test. This is generally made to see that the maker meets guarantees, and all subsequent tests should be compared with this one. Results of turbine tests made by reputable engineers can be easily obtained and are frequently reported in the technical magazines. The engineer should compare these results with his own, using the figures on turbines similar to his, and if his are not up to the mark, he should find out why, and set to work to improve them. This not only means a saving to his employers, but reflects to his credit, inspiring confidence in his ability, watchfulness and reliability.

To summarize—the engineer should

1. Make frequent inspections.
2. Keep the condensing apparatus in condition to maintain the highest possible vacuum.
3. Make tests when thought advisable.
4. Keep the blading in the best repair possible and adjusted to produce a kilowatt at the lowest possible cost as determined by test.
5. Give particular attention to the governor and valve-gear adjustment.
6. Use great care in assembling.

Distortion of Indicator Drum Motion

By Julian C. Smallwood*

Results of an experimental investigation of the inaccuracies of indicator drum motion caused by the variable stress, and consequent stretch, of the indicator cord.

*Associate professor of experimental engineering, Syracuse University.

Stress in an indicator cord is the resultant of three distinct forces; namely, the drum-spring tension, the force required to overcome the inertia of the drum, and the force of friction between the drum and its spindle. The force of the spring increases with the forward stroke of the drum and decreases upon the return; the increase is usually uniform with the motion.

In general, at the beginning of the forward stroke, inertia increases the cord stress since, as the speed is increasing, inertia effects a tendency of the drum to lag. Beyond midstroke, however, the speed is decreasing, and, as the drum tends to exceed the velocity induced by the cord, a slackening results. Upon the return stroke the force of acceleration varies in the same way as upon the advance.

The force of friction is always opposite to the drum motion and therefore changes its direction at each stroke. During the forward stroke it tends to increase the cord stress, and upon the return to decrease it. The three forces and the resultant cord stress are represented graphically by Fig. 1.

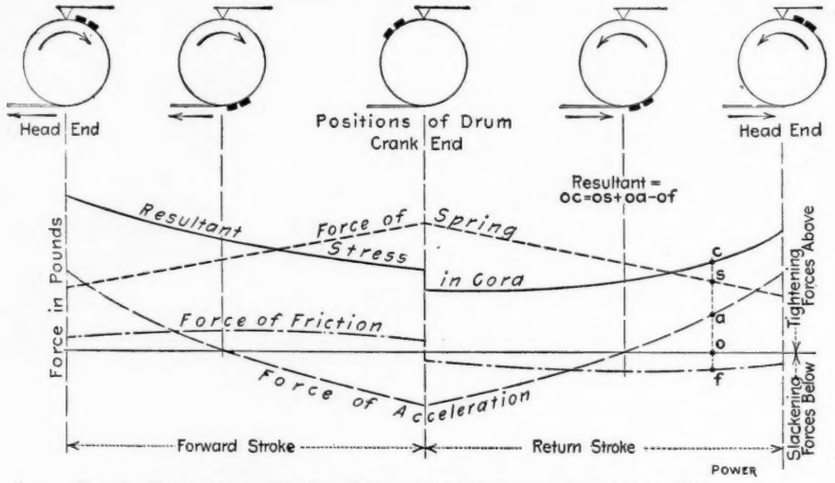


FIG. 1. DIAGRAM OF FORCES PRODUCING STRESS IN INDICATOR CORD AT DIFFERENT PARTS OF STROKE

CORD STRESS DIAGRAMS

Autographic cord-stress diagrams obtained by the use of a Brown drum-spring tester,† in which stress is represented vertically and stroke horizontally, are shown in Fig. 2. The diagrams bear the records (by the dotted lines) of cord stress at dead slow speed. At the higher tensions, these records are double lines, for at such tensions the friction is materially increased. At less than 100 r.p.m. there is practically no effect from inertia, the curve at such speeds being closely coincident with the "no-speed" curve. As the speed is increased, the resultant cord-stress curve approaches the horizontal because the increased force of acceleration tends to equalize the cord stress. When the speed is made still greater, the force of acceleration predominates and the slope of the cord-stress curve is reversed.

It was found that an increase in the spring tension at a given speed made the range of stress higher with a greater difference between the stresses at corresponding points on the forward and return strokes.

RELATION BETWEEN STRETCH AND STRESS

Experiments to determine the relation between the stretch of the cord and the stress causing it yielded unexpected results which, because of the general application of the principle discovered, were presented in a paper on "The Exception to Hooke's Law," appearing in the October, 1911, issue of the *Physical Review*. The purpose of the tests was to find if the stretch of the cord varied in the same way as under static conditions when the stress is rapidly applied, as is the case in the operation of the indicator. The following facts were established: First, the relation between stress and stretch is independent of the speed of variation of the stress. Second, for increasing stresses, over about 1 lb., the stretch increases uniformly with the stress, according to Hooke's law. Third, for decreasing stresses, the stretch decreases according to a different law. This is because the work done upon the cord, when an external force stretches it, must be greater than the work returned by the cord when its fibers draw up, due to the friction of the fibers upon one another. The effect is a "lag" in resuming the original length, which increases the drum-motion distortion.

Turning to the effect of the established variations of stress and stretch upon the drum motion, it may be observed that the ideal operating condition demands constant cord stress. This, however, can never be attained, but disregarding friction, there is one speed at which the resultant of the spring and acceleration forces is approximately constant through the stroke for any particular drum and spring.

If an indicator drum be put on its extremes of travel and vertical lines made on the card to indicate these extremes then horizontal lines made at increasing speeds will overtravel the vertical ones. From the diagrams of Fig. 2, it is seen

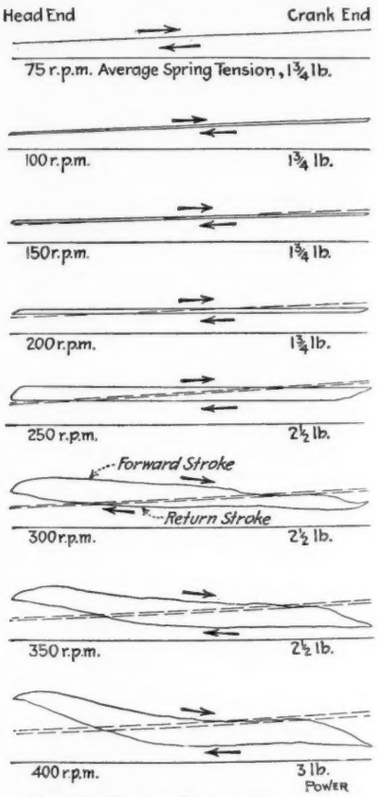


FIG. 2. CHORD STRESS DIAGRAMS

†The drum-spring tester diagrams presented in this article were taken by Edward H. Zeiber.

that the effect of speed is to increase the stress at the head end and decrease it at the crank end. At the head end, therefore, the cord is longer and the drum travels further in this direction. Similarly, at the crank end, the cord is shorter and the drum is pulled further toward that end.

Overtravel in itself does not cause error in the indicator diagram, although it generally accompanies it. If the whole diagram were lengthened uniformly, its proportions would remain correct. A uniformly increasing cord stress would have this effect because then the cord stretch would be uniform and the diagram would be merely lengthened uniformly in all its parts, but a uniformly decreasing cord stress would not have this effect because of the property of the cord to lag. At any point of the indicator diagram, its error should not be judged by the absolute stress or stretch at that point, but instead by the difference between this stress or stretch and that necessary to produce a uniform lengthening.

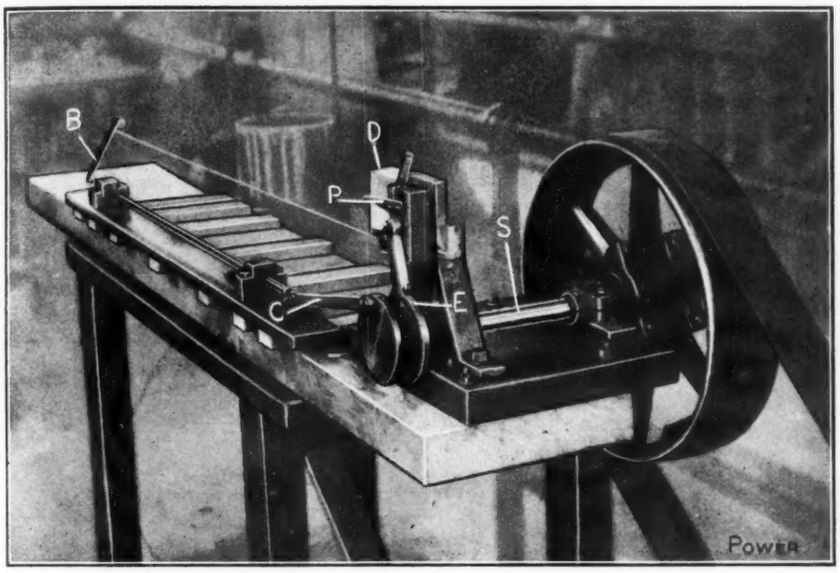


FIG. 3. VIEW OF APPARATUS FOR RECORDING INDICATOR DRUM MOTION

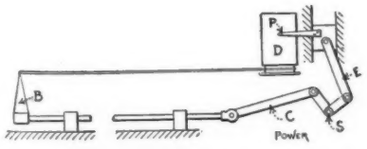


FIG. 4. SHOWING PRINCIPLE OF APPARATUS FOR RECORDING DRUM MOTION

The following reasoning has reference to conditions such as shown by Fig. 2 at speeds above 200 r.p.m. During the forward stroke, the cord stress is decreasing in value, but not uniformly; hence the cord is too long and a point on the resulting indicator diagram is to the left and behind its correct position. The effect of cord "lag" with decreasing stress is to make the cord still longer, and to increase the error. During the return stroke, by similar reasoning, the cord is too short, a point on the diagram obtained is to the right and again behind its true position, since the motion is reversed. There is no effect from cord lag on the return stroke since the stress is increasing. The net effect of the stretch of the cord, then, is to make the mean effective pressure appear smaller, and the cutoff, compression and release earlier than their true values.

EXPERIMENTAL RESULTS

The distortion of the diagram could be determined inferentially from the analysis already presented. For experimental verification, however, the author devised the apparatus shown in Fig. 3 and illustrated diagrammatically by Fig. 4. A shaft *S*, whose rotary speed could be controlled by a motor having a water rheostat in its armature circuit, actuated two similarly proportioned crank trains, *E* and *C*, set exactly 90 deg. apart. The motions of the two crossheads were thus exactly proportional at all parts of their strokes. The indicator drum *D* was rotated by fastening its cord to a bracket *B* carried on an extension of the horizontally moving crosshead. The crosshead with vertical travel carried a pencil point *P* which traced a diagram upon the drum. A diagram thus obtained is one of the crosshead motion shown vertically and drum motion horizontally. If a rigid connector between the drum and the bracket had been used instead of an indicator cord, the motion of the drum would have been exactly proportional to that of the pencil, and the diagram would have been an inclined straight line. The effect of an elastic connector, as cord, variously stressed, is to give a curved line. If a straight line is drawn between the highest and lowest points of this curve, then the horizontal departure of any point on the curve from the straight line shows the error in the drum motion at that point.

Fig. 5 shows a typical "error diagram" taken with this apparatus, and Fig. 6 the method of correcting the indicator diagram by its use.

Tests were made on two indicators, *A* and *C*, of the same make, the former with a 2-in. drum and the latter with a 1¾-in. drum; hence the inertia effects of *C* were somewhat less than those of *A*. Two kinds of cord were used, but the error diagrams presented are all for one cord, a 4-ft. length of which was used. The stroke of the horizontal crosshead was 3.72 in., corresponding to a diagram 3.72 long at no speed. Tests were made for various spring tensions and for each the engine speed was varied from very slow to about 350 r.p.m. The effect of the forces previously analyzed

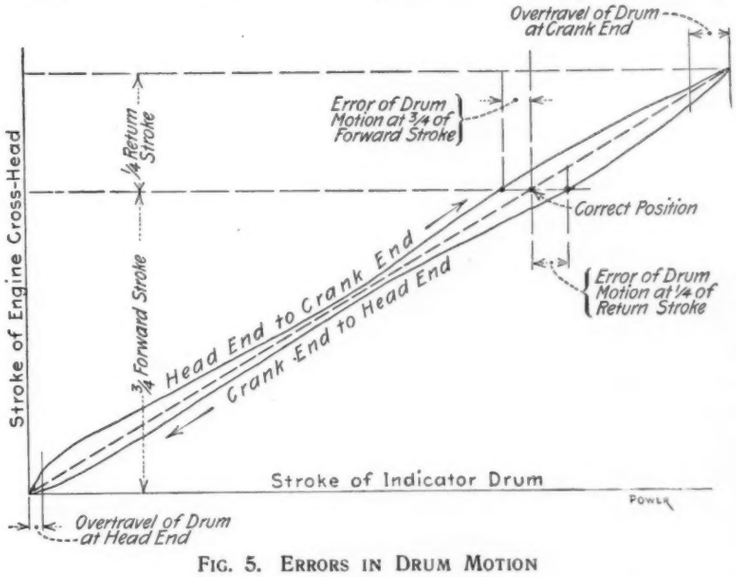

Overtravel of Drum at Crank End
Error of Drum Motion at ¾ of Forward Stroke
¼ Return Stroke
Correct Position
Error of Drum Motion at ¼ of Return Stroke
¾ Forward Stroke
¾ Head End to Crank End
Crank End to Head End
Stroke of Engine Cross-Head
Stroke of Indicator Drum
Overtravel of Drum at Head End
POWER

FIG. 5. ERRORS IN DRUM MOTION

was obtained by leading the cord straight from the indicator drum. A series of similar tests was made with the cord running over one and two guide pulleys, such as are almost invariably used when indicating an engine, and these, perhaps, yielded the most interesting results of the whole investigation.

Referring to Fig. 7, it is seen that the best spring tension for indicator *A* when running at 300 r.p.m. is between 3 and 4 lb. A higher value increases the distortion by increasing the friction caused by the reaction on the drum spindle. With a 4-lb. spring tension, the maximum error is 0.1 in., occurring at about one-eighth of both forward and return strokes. The 1½-lb. spring tension gives excessive distortion, at the maximum, 0.37 in. The crank-end overtravel shows by its amount that the cord stress was reduced to zero at this end, yet there was no visible slackening of the cord. This phenomenon has been frequently observed, that the drum will actually overtravel the cord at the crank end, but not until the overtravel has become excessive will the slackening and consequent vibration of the cord be apparent to the eye.

Fig. 8 shows that at 150 r.p.m. the indicator diagram was practically correct. At 250 r.p.m. the errors grade from zero to about 0.1 in. at several points in the stroke.

The effect of horizontal distortion upon measurements from the indicator diagram will vary greatly with the type of diagram. A diagram having late cutoff and compression will be but little affected as distortion of horizontal lines appears only at their ends. Also, in general, the less the area of the diagram, the more will be the percentage of error in the mean effective pressure. But the effect of horizontal distortion upon the apparent positions of the events of the stroke may be large and may involve considerable inaccuracy in such calculations as for cylinder condensation, clearance, the equation of the expansion curve, valve setting, etc.

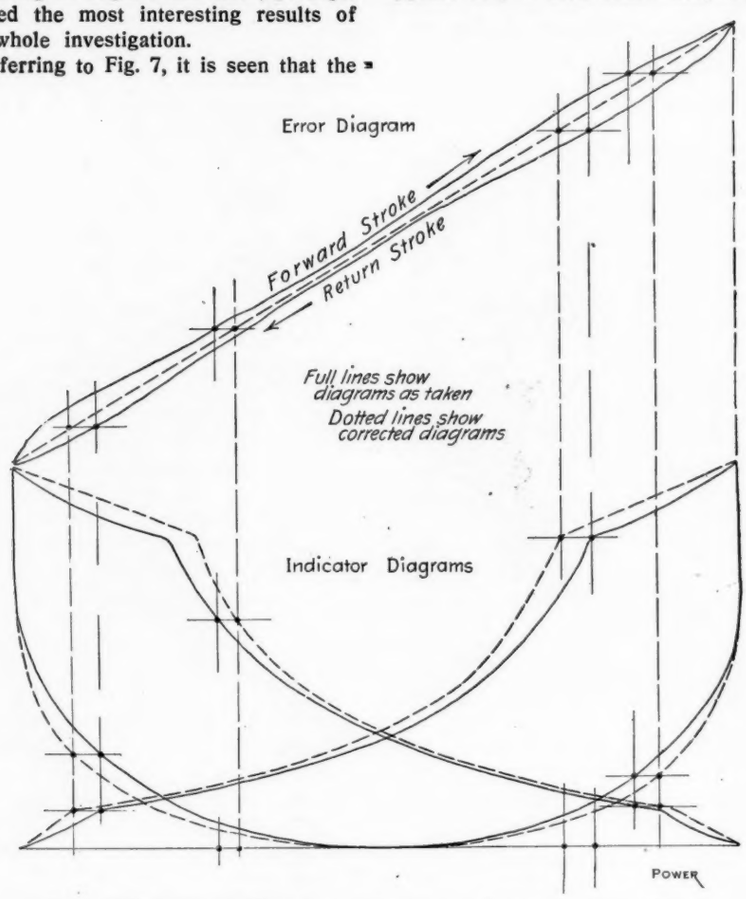


FIG. 6. METHOD OF CORRECTING INDICATOR DIAGRAMS FROM ERROR DIAGRAMS

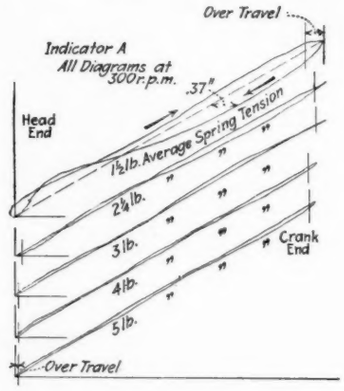


FIG. 7. EFFECT OF TIGHTENING DRUM SPRING

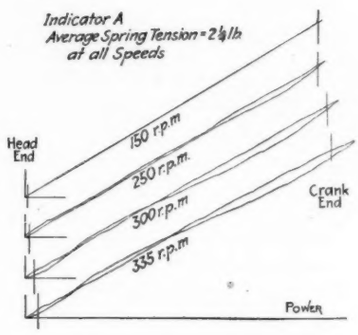


FIG. 8. EFFECT OF SPEED

GUIDE PULLEYS

The effect of guide pulleys used near the indicator is similar to that of drum-spindle friction and imposes an additional tightening force on the forward stroke and slackening one on the return. This is clearly shown by Fig. 9, from which it appears that the errors are not only very materially increased at the higher speeds but, at the lower ones distortion is created where it did not exist before. The further the pulley from the indicator, the less is its effect to stretch the cord abnormally.

It is impossible to offset the stresses due to guide pulleys by tightening the drum spring, the effect being merely to increase the friction still more and to aggravate the trouble. Furthermore, it appears from the results that it is impossible to get a correct diagram at any speed, even if the best quality of cord is used, when the cord is more than 2 ft. long and run over a guide pulley.

Fig. 10 shows the effect upon indicator diagrams of the errors presented by Fig. 9. It may have been observed in some of the error diagrams that the drum advanced its correct position instead of lagging behind it on the return stroke. This is caused by the departure of the acceleration force from the variation assumed in Fig. 1 because of the stretch of the cord and the consequent change in the driven velocities.

GENERAL DEDUCTIONS

The obvious method of reducing horizontal error is to use cord which stretches so little as to make the errors in all cases inappreciable. There is, however, no such cord on the market to the writer's knowledge, the best obtainable giving a stretch of 0.008 in. per pound per foot of length. Using 4 ft. of this cord, indicator *C* could be run at 300 r.p.m. with a maximum error of 0.06 in., but one-eighth of a turn about a guide pulley caused this error to be more than doubled.

The price of indicator cord is no criterion of its quality; hence it is advisable to test the cord to be sure that it does not stretch excessively. This may be simply done as follows: Tie one end of about 4 ft. of the sample to a fixed point on a bench or table and the other end to a spring balance. Mark this end a few inches from the balance with a fine ink line, and under this line place a piece of paper or a foot-rule. Stretch the cord by pulling the balance horizontally until about 5 lb. are indicated. Now reduce the force to about 1 lb., and repeat this procedure a few times. The elongation may then be noted for any applied range of stress. As the cord in the operation of the indicator is generally not stressed more than 5 lb. or less than 1 lb., this range was used in the results previously quoted. A good cord should not stretch more than 0.03 in. when stressed to 2.5 lb. It will be found, however, that the elongation and contraction of the cord are very much greater at stresses less than 1 lb. This explains the phenomenon that there may be marked overtravel at the crank end of the drum motion and yet the cord will not show it by visibly slackening or vibrating.

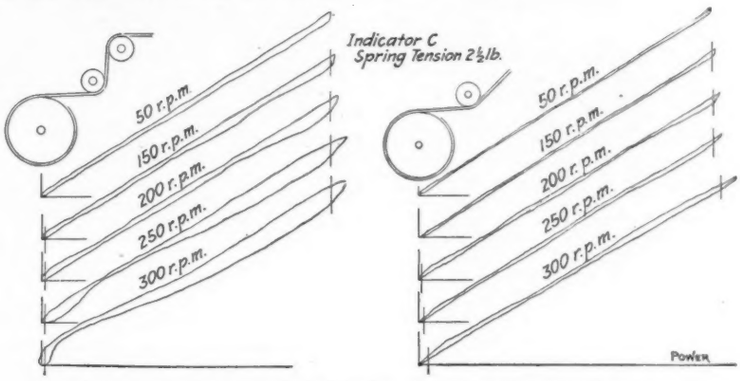


FIG. 9. EFFECT OF GUIDE PULLEYS AT DIFFERENT SPEEDS

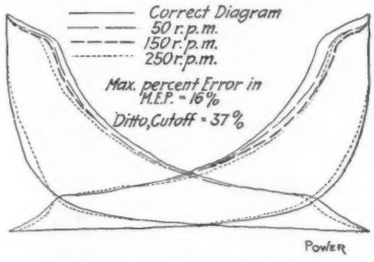


FIG. 10. EFFECT OF TWO GUIDE PULLEYS AT DIFFERENT SPEEDS

The writer has experimented with a number of high-grade stranded bronze wires, but has found none conveniently adaptable to indicator work. Such wire may be obtained sufficiently light and stiff, but it wears out very rapidly when subjected to flexure in operating an indicator drum.

For accurate work and where guide pulleys are unavoidable, wire may be used to advantage as part of the connector. A short piece of indicator cord, about 4 in. long, may be wrapped about the drum and to it the wire attached. Wherever the connector passes over a guide pulley, a short length of cord pieced to the wire may be used. Such an arrangement, though effective, is inconvenient to set up, and, unless the wire is very flexible, it will kink and act as a spring, causing worse error than would a cord.

The effects of inertia may be reduced by adjusting the length of the diagram. The force of acceleration varies directly with the length of the stroke of the drum and with the square of the engine speed. Assuming that a particular indicator gives a reasonably correct diagram S inches long at a speed of N revolutions per minute, then at another speed, n, and diagram length, s, if

$$S \times N^2 = s \times n^2$$

there will be the same inertia forces. Applying this to indicator A, it is found from the error diagrams and from the cord stress diagrams that this indicator will give practically no error at 200 r.p.m. and a 3.6-in. diagram. Then, if it is wished to run at a speed of 250 r.p.m., the length of the diagram should be

$$s = \frac{SN^2}{n^2} = \frac{3.6 \times 200^2}{250^2} = 2.3 \text{ in.}$$

However, not much use can be made of this method as, at 300 r.p.m., the diagram becomes so short as to be impracticable.

The inertia forces may be balanced at different speeds by using different stiffnesses of spring, but this, too, is generally impracticable.

In conclusion it may be said that, for accurate work, it is necessary in most cases either to use an indicator especially adapted to the operating speed, or to use wire instead of cord. Guide pulleys should under all conditions be avoided. When a small percentage of error in the results from engine indications is not objectionable, the ordinary indicator may be employed, but the best quality of cord only should be used except at the speed for which the instrument is adapted.

Replacing Boilers and Engines

BY F. C. SNEIDER

The work of installing new engines and boilers to replace those in service is dreaded by both manufacturer and engineer. While the time lost in completing the work is usually a large item, in the following case much time and money were saved by exercising judgment and foresight.

Two horizontal return-tubular boilers, each 18½ ft. long and 72 in. in diameter, were removed and the new boilers of the same type and size installed, with a loss of but five working hours. An old 20x48-in. Corliss engine was also removed and a new 22x48-in. Corliss engine erected on the original foundation with a loss of only seventeen working hours. This shows how little actual working time need be lost if the work is done when power is not required, as on holidays and Sundays.

As it was decided to install the new boilers on Labor Day, at 6 p.m. on the preceding Friday the fires were drawn and the work of removing the old boilers begun. At 6 p.m. the following day both boilers and settings had been removed and the settings for the new ones started. The bricks used in the new settings were dipped in water and firmly rubbed to the surface of the adjacent bricks. This accounts for the satisfactory manner in which the walls withstood the intense heat to which they were so soon subjected.

The new boilers were resting on their settings at four o'clock Sunday afternoon, and as soon as the necessary connections were made the boilers were filled and the fires started. The masons and steam fitters in the meantime completed the brickwork and boiler connections. The steam pressure was gradually increased on Monday night so that at 7 a.m. Tuesday the engine was started on the day's run. The total time required to renew the boilers, settings and connections was 75 hours, and the actual loss to tenants only five hours.

Thanksgiving Day was chosen to remove the engine, and at 4 p.m., Nov. 29, the work was begun. At 4 p.m. Saturday the old engine had been removed and the foundation made ready by removing the top bricks to a depth of 24 in. and substituting a bed of concrete of the same thickness. At 4 a.m. Monday the erecting was completed and the engine started. The speed was gradually increased so that at 7 o'clock the full load was thrown on the engine. The total time required for this installation was 111 hours, but the actual working time lost to the tenants only 17 hours.

While the engine was being installed the belts, idlers, jackshafts and pulleys were renewed, and as the pumps, piping, etc., were new or thoroughly overhauled during the preceding year the generating

equipment of the plant was practically renewed with a loss of only 22 working hours. When it is considered that 10 shoe manufacturers employing nearly 5000 hands are dependent on this plant for heat, light and power, the saving of time over what is usually required for such installations represents a considerable sum of money.

Single and Twin Filter and Grease Extractors

The Elliott Co., 6907 Susquehanna St., Pittsburgh, Penn., is manufacturing two types of filters and grease extractors. The single filter consists of a filtering chamber containing the filtering media and a divided base directing the flow of liquid through the filtering chamber or bypass when cleaning. Valves are provided at the end of the base to put the filter in or out of service. Terry cloth of double thickness and supported by spacers and spreaders about a central column is used for the filtering media.

The twin filter consists of two filtering chambers having a common base, but is otherwise constructed similarly to the single filter except that the bypass is eliminated.

Referring to Fig. 1, the liquid to be filtered enters at the left from the feed pump and passes up and out through the central slotted column, coming in contact with the filtering media, which removes the impurities. The filtered liquid then passes into the surrounding chamber, down and out at the right into the line to the closed heater or wherever desired.

To clean the filter, the flow is directed from the filtering chamber containing the fouled media by shifting the valve at either end. By admitting water from the feed line through the connection in the filtering chamber, the direction of flow is reversed, and the water will partially remove the impurities from the interior surface of the filtering material and discharge them through the drain in the base. Fig. 2 shows a filtering cylinder removed from the filter body.

FIG. 2. CYLINDER REMOVED FROM FILTER

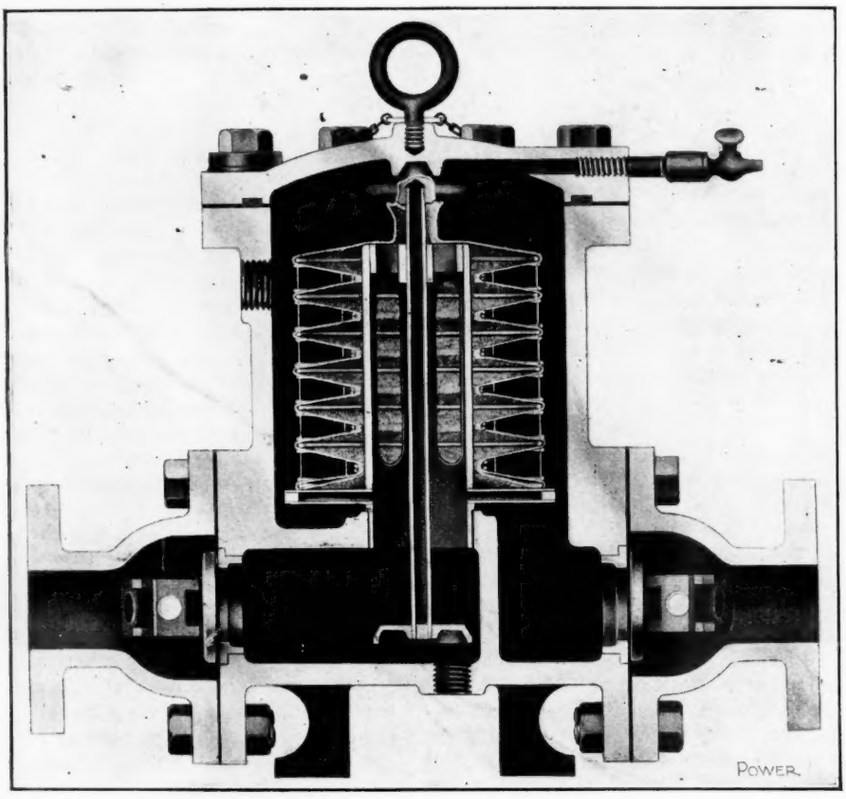


FIG. 1. SECTIONAL VIEW OF GREASE EXTRACTOR

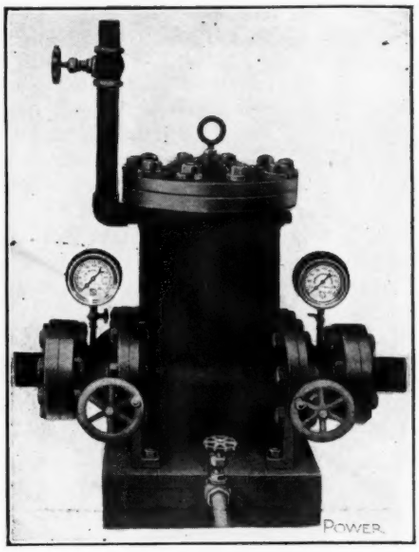
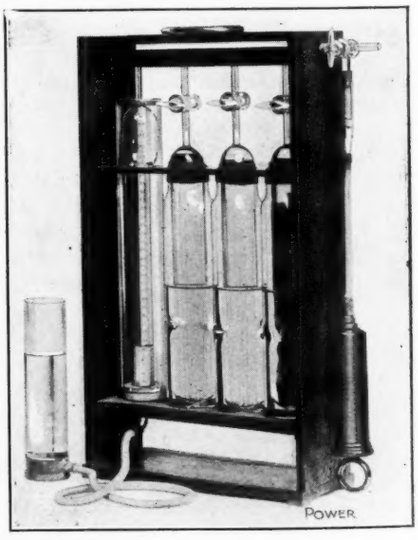


FIG. 3. EXTERIOR VIEW

The filter is made in capacities of from 20,000 to 250,000 lb. of water per hour.

Williams Improved Flue Gas Apparatus

The instrument illustrated is compact and portable and is designed to facilitate the work of the operator. The measuring burette is placed at the left side, allowing freedom of the right hand in manipulating the stop cock, etc.



WILLIAMS IMPROVED FLUE-GAS APPARATUS

The explosion burette is fitted with terminals permanently connected to binding posts on the outside of the case. The bulb is low upon the tube, permitting 15 c.c. of clear gradation on the small calibre of the burette above the swell. There are two forms of absorption pipette, the simple and the bubbling, either form slipping interchangeably into the pipette jar or solution reservoirs, and the closure at the top is effected by a rubber band.

The bubbling pipette accomplishes absorption very rapidly because the gas is caused to bubble through a long column of liquid, and the bubbles are finely broken up by the thin glass tubes with which the pipette is filled to give a large absorption area in the wet surfaces of these tubes.

The detachable three-way T-stop-cock with hard-rubber pump and valves makes it possible to take a dry sample of gas directly from the source of supply, eliminating the inaccuarcy and bother of collecting over water, transference, etc. After connection with the supply, the pump is operated, discarding the gas in the connecting line until the fresh sample is brought up to the apparatus, when, by turning the stop-cock and lowering the water-level bottle, the measured sample is taken directly into the burette.

The introduction into the line of an aspirator tank also enables an average sample to be taken covering any desired period of time. This method of control has advantages in that its accuracy and adjustment are unquestionable. It is also possible to determine carbon monoxide.

The apparatus is manipulated by lowering the water level and, after closing the three-way stop-cock, drawing the solutions in the pipette up to a definite reference mark on the capillary tubes, about midway between the stop-cock and the body of the pipette. The stop-cock is then opened and by raising the water-level bottle the burette is completely filled with water. The apparatus is then ready for a sample.

The device is connected either with the gas supply directly, or with the sample-collection bottle, and with a few strokes of the pump a fresh sample of the gas is drawn up to the apparatus, discarding the air in the connecting line out through the slit or valve. The stop-cock is then turned until the head is on top and, by lowering the water-level bottle, a little more than 100 c.c. of the sample is drawn into the burette. This is allowed to stand until the gas has come to the temperature of the apparatus when a final adjustment is made to 100 c.c. When readings are taken, the bottle is held so that the water level is the same as that in the burette.

This apparatus is manufactured by F. M. Williams, 43-44 National Bank & Loan Bldg., Watertown, N. Y.

Air Compressors in the Transvaal

In the Transvaal mines, South Africa, according to the government mining engineer, in 1910 there were 257 compressors, with 100,291 hp., while only 400 hp. of compressed air was purchased. No separate returns of the value of air compressors were rendered to the department.

The gold mines in the Johannesburg consular district employ on an average three 50-drill compressors on each mine for the driving drills. The value of the total imports for both gold and coal mines for the period mentioned was $543,402. Up to about two years ago the air compressors were almost entirely driven by steam, but since then electric power has been furnished to nearly all of the mines, and steam power for air compressors has been superseded by electricity.

Purchased Current for Summer Service

In a recent contribution to a discussion before the City Club of Chicago, W. A. Blonck, consulting engineer of that city, brought out some interesting points tending to show that it would be to the mutual advantage of both the public-service corporation and the office-building owner if the isolated plant in the average office building were closed down during the season when steam-heating service is not required and the current necessary for light and power were purchased from the central station.

In driving home his arguments he pointed out that but 12 per cent. of the coal burned in the central station is converted into salable energy, the rest is simply used to heat that particular body of water which supplies the condensers. On the other hand, 70 per cent. of every ton of coal burned in a heating plant is converted into usable heat and about 200 kw.-hr. can be obtained as a byproduct, the latter representing a value of from $6 to $20, depending on the rate at which it is sold. From this it will be seen that the building owner who operates a moderately large heating plant during the heating season without availing himself of the electrical energy obtained with but a very slight reduction in the heating effect of the coal, may be compared with the old-fashioned butcher who sold only the meat and threw the rest of the animal away, while it is well known that the modern packer has grown rich on the profits from that part of the animal which but a few years ago was considered valueless.

Entirely different, however, is the aspect in the summer months when the coal is used solely for generating current. Then, according to Mr. Blonck, the owner must purchase, haul by wagon and burn in the congested district, say 4 tons of coal to develop a given amount of electrical energy which can be produced at the central station from about 1 ton. Thus, considering the matter from a manufacturing viewpoint, if the larger manufacturer, or central station, pays $1 for its raw material the small manufacturer, or building owner, must pay $5 for the raw material necessary to produce the same amount of finished product. This is allowing $1 for buying and handling in team-load lots instead of car-load lots.

It seems evident, then, that the building owner should be able to buy electrical service from outside source in the summer cheaper than he can produce it, and allow a good margin of profit for the public-service corporation. The central station would secure a larger summer load. This would mean a higher yearly load factor, decreased fixed charges per unit of energy delivered and greater revenue. The property owner would benefit financially because he would get current during the summer for less than it would cost him to make it. He could afford to use chaper engines because their efficiency is of relatively small importance when all the exhaust steam is being used for heating; hence his total investment would be less. Finally, during the summer he would be rid of the radiant heat of the boilers, engines, piping, etc., as well as the dust and dirt caused by coal and ash handling.

The city as a whole would be bettered because there would be less smoke and 50 per cent. of the coal now burned during the summer in the business district would be saved.

Faulty Separator Trap Connection

By E. B. Lloyd

High-speed, automatic cutoff engines are frequently damaged by water entering the cylinders. To prevent this the steam pipe should contain a reliable trap-drained separator placed as close as possible to the engine, and the cylinder should have drains and dependable release valves.

The separator-trap discharge and cylinder and steam-chest drains are frequently found emptying into the exhaust pipe close to the cylinder. The separator trap should discharge into a return tank or into the sewer and never into the exhaust pipe, or into the same line with the other drains from the engine.

When an automatic engine is first brought up to speed with no load the cutoff is so early that an indicator diagram would show practically no steam line and frequently the expansion line would be carried below the atmospheric line, forming a negative loop.

Under such a condition, the pressure in the exhaust pipe exceeding that in the cylinder when the valve is opened, the previously exhausted steam along with the water discharged from the separator trap rushes into the cylinder and the cylinder drain cock at that end of the cylinder if it is open.

The result is at least a disagreeable valve slap, if not a blown-out cylinder head, a bent crankshaft or a ruptured flywheel.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Ground Detector for High Tension Circuits

By J. W. Himmelsbach

While there are a number of instruments on the market for indicating the presence of a ground on a high-tension circuit, they are practically all of the static type. Although operating satisfactorily, they as a rule only indicate a ground; consequently, unless the operator happens to be where he can see the indicator, he may be unaware that a ground exists. To provide a detector which would not only indicate, but also notify the operator, called for the design of the apparatus herein described. This will not indicate the magnitude of the ground, but only its presence, and if used in conjunction with static detectors it provides a reliable and sensitive means of attracting the attention of the operator; he may then look at the static detectors to ascertain the intensity of the ground and also the individual phase or phases affected.

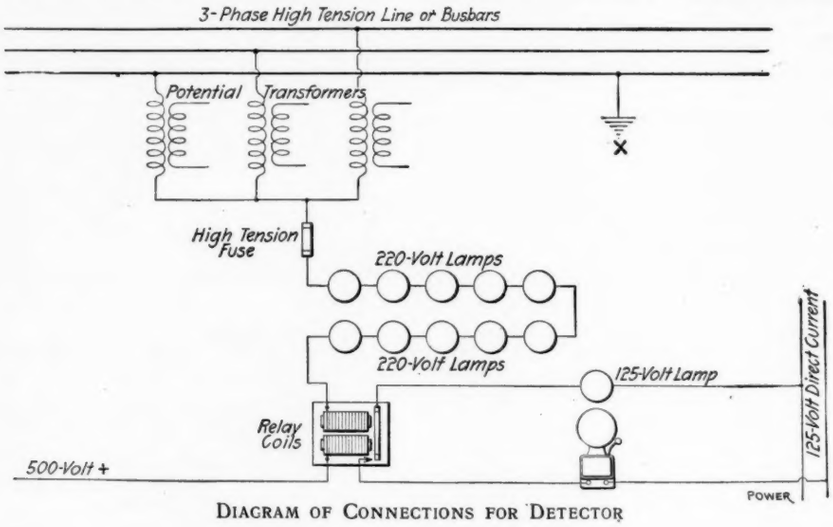


Diagram of Connections for Detector

A source of direct current is necessary, preferably a three-wire, 500-volt system, with a grounded neutral. For application to a three-phase, three-wire system the following material and apparatus is needed: Three potential transformers, with the high-tension winding designed for the voltage of the system, ten 16-cp. 220-volt incandescent lamps, one 16-cp., 125-volt lamp, one telegraph relay, wound for about 1000 ohms, and one ordinary electric alarm bell.

The primaries of the potential transformers are connected in star, across the three wires of the system, the secondaries being left open and the ends well taped to prevent accidental short-circuits. From the neutral point of the primaries, a wire is run to one terminal of a high-tension fuse and from the other terminal of the fuse a wire is run to one end of a bank of ten 16-cp., 220-volt lamps, connected in series. From the other end of the bank of lamps a wire is run to that binding post of the relay to which the magnet coil is connected. The other end of the relay coil is connected directly to the positive side of the 500-volt direct-current system. The 16-cp., 125-volt lamp is connected in series with the bell across a 125-volt direct-current circuit, the contacts on the armature of the relay closing this circuit. A storage or dry battery may be used in place of the 125-volt circuit, by omitting the lamp, but the former method is the better, for, in case the bell refuses to operate the lamp will light. A full diagram of connections is given in the illustration. The operation of the apparatus is as follows:

Suppose a ground to develop as at *X;* then, keeping in mind that there is a potential difference of 250 volts between one side of the 500-volt circuit and the ground, a current will flow from the positive wire, through the relay magnet coil, to the lamp bank, through that to the fuse and on to the neutral point of the transformers. At that point the current will select the transformer connected to the grounded phase and so flow to the ground. The current passing through the relay coil attracts the armature which in turn closes the contact in the auxiliary circuit; with this closed the lamp will burn and the bell ring, thus calling the attention of the operator.

This apparatus has been found to work admirably in spite of two disadvantages, which, although undesirable, are nevertheless unavoidable. First, connecting the apparatus to a three-wire system, operating with an ungrounded neutral paves the way for a difference of potential between any phase wire and the ground equal to 250 volts plus or minus the system voltage divided by $\sqrt{3}$; in a system operating at 6000 volts between phase wires, the potential difference between any phase wire and the ground is equal to 250 volts plus or minus 6000 divided by 1.73, which is equivalent to a varying potential of from 3210 volts to 3710 volts. The other disadvantage is, that on any occasion when lightning happens to strike one of the wires the invariable result will be the burning out of the magnet coil. However, the first may be in part cancelled by exercising greater care in coming in contact with the line wires, and the second will not occur so frequently as to make the item of rewinding the coils very expensive.

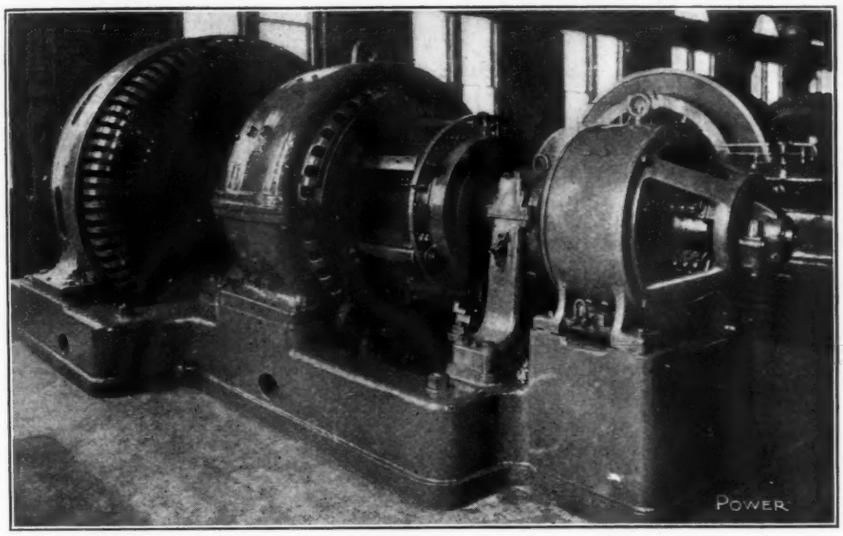
Synchronous Motor-Generator

An interesting application of a synchronous motor-generator for power-factor correction is that at the plant of the Spang Chalfont Co., at Etna, Penn. There are two mills, one near the power house and the other about 4500 ft. distant. Under the conditions that obtained in the plant prior to the installation of the synchronous motor set, the first mill was operating at a power factor of about 48 per cent. Another synchronous set previously installed takes care of the second mill, originally at about as low a power factor. Therefore, before the present set was installed, the generators at the power house were operating at about 75 per cent. power factor. To carry the load at this low power factor it was necessary to operate four generating units, leaving no spare.

The low power factor was due to the presence of a large number of induction motors which are underloaded for a considerable part of the time.

The synchronous motor-generator set was temporarily installed in its present location in the power house to raise the power factor sufficiently to permit keeping one or two of the four generating

units shut down. This renders available one or two spare units. Moreover, the direct-current generator of the synchronous motor set now carries the load of a former direct-current engine-driven gen-



SYNCHRONOUS MOTOR-GENERATOR SET FROM EXCITER END

erator, still further increasing the economy.

In operation, the synchronous motor of the set is overexcited, thereby raising the power factor of the generators to 97 or 100 per cent. Under existing conditions, the motor is usually operated at 20 per cent. leading power factor. At present the actual kilowatt load on the generator of the set is small, which, with full input to the motor, accounts for the low leading power factor.

The set is driven by a 220-volt, three-phase, 60-cycle synchronous motor rated at 1000 kilovolt-amperes, and running at 600 r.p.m. It is of the three-bearing design and has, for the synchronous motor, a direct-connected exciter, overhung on the shaft, beyond the generator outboard bearing. The illustration shows the set from the exciter end. The generator is a direct-current, 400-kw., 220-volt, compound-wound machine.

CORRESPONDENCE

Wattmeter Problem

The diagram shows a proposed wattmeter installation on which I would like to have comments.

Consider two alternating-current generators connected in parallel through oil switches *A* and *B* to the main busbars. The generators are connected near the middle of the busbars while power circuits are run from each side. It is desired to install a recording wattmeter to make a total output chart of the station load. Owing to the nature of the installation, current transformers in the main busbars will not carry the total power current.

If the wattmeter should be installed as shown, would it give a true indication of the load on both generators? The sketch shows the secondaries of the current transformers on corresponding legs of each generator connected in parallel and supplying the current coils of the instrument. The small switches *a* and *b* in the secondaries of the current transformers are opened and closed automatically with the operation of the oil switches *A* and *B*.

These small switches are for opening the secondary circuits of the current transformers on the generator when not in use, thereby eliminating the shunt path which would exist through the current transformers on the idle machine.

The middle junction point of the transformers and one terminal of the instrument coils are shown grounded. Under what conditions would the instrument give a true indication and under what condition would its accuracy be affected?

League City, Texas. C. L. GREER.

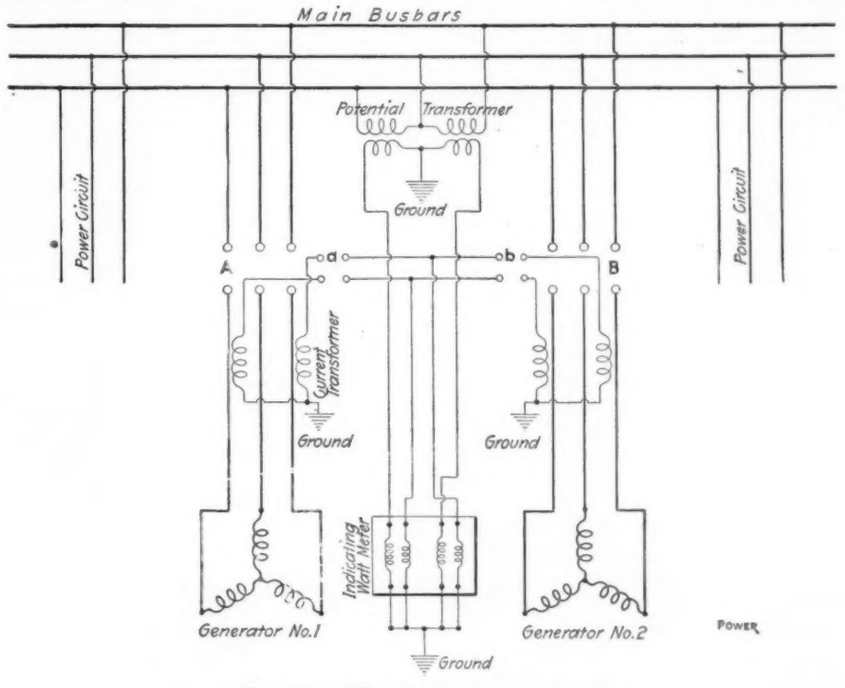
What Made Transformers Heat

Mr. Fisher's comment under the above caption in the July 30 issue is incorrect. Although the secondary voltage is high as stated, there can be no current flowing when the secondary circuit is opened; hence the heating cannot be due to excessive secondary current. Just as soon as this circuit is closed, so that normal current can flow, the secondary voltage falls to its normal value.

Mr. Brindley's transformers became hot upon removal of the meter, because he prevented the flow of current in the transformer secondary; this current being normally in such a direction as to oppose the primary current in setting up flux in the transformer core. The primary current alone caused an excessive flux in the core with large losses in the iron, due to eddy currents and hysteresis, and these heated the transformer.

Another bad effect of the large flux was a comparatively high voltage across the terminals of the secondary winding, which in some cases has given a dangerous shock, or broken down the insulation between turns and ruined the transformer. Workmen accustomed to handling current transformers always short-circuit the secondary circuit before breaking any connections, and thus avoid danger to themselves or the transformers.

York, Penn. H. R. DIETTERICH.



PROPOSED WATTMETER CONNECTIONS

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

Exhaust Piping

By James H. Beattie

The exhaust pipe of a gas engine is a part of the installation that should be laid out and installed with as great care as is given any other part. Many think it sufficient to run the exhaust to the most convenient point outside the building, irrespective of the size of the pipe employed and the number of turns necessary to get to the desired point. Consequently many an engine has been condemned when the real fault was lack of proper facilities for getting rid of the burned gases from the cylinders.

The burned gases from the average engine are released at a pressure considerably above atmosphere and escape must be provided so that the pressure will drop to that of the atmosphere almost immediately, or the engine will not develop its rated power without consuming excessive fuel. Permitting the exhaust to escape directly to the atmosphere is objectionable on account of the noise, so some sort of a muffler is usually used. Mufflers, if not properly designed, are likely to increase the back pressure on the engine and cause loss of power. Desire to make their machines quiet has led many manufacturers to put on mufflers, which, while very effective in reducing noise, sometimes rob the engine of considerable power.

A medium-size stationary engine had been in use for nine years, operating a deep-well pump. It had received very little attention and had been losing power until it could operate at only partial capacity. The batteries had been changed from time to time and the engine was to all appearances in fair condition. The exhaust pipe ran up through the roof, and a muffler was attached to the end of the pipe. This muffler is shown in section in Fig. 1. It consisted of a spherical shell perforated with two transverse slots. These allowed the gases to escape into the space between this inner shell and the two halves of the muffler walls. These two halves were bolted together, the flanges being serrated so that the gases could escape. These openings had become clogged with carbon until there was very little means of escape for the exhaust. A thorough cleaning of the muffler and grinding the valves put the engine in good condition again.

Another engine was installed by the purchaser and failed to develop the rated power. As a last resort a man was sent from the factory and found that the engine had been connected up with nine elbows in the exhaust line and that the pipe was the same size its entire length, although nearly 100 ft. long. The pipe was rearranged so that four 45-deg. elbows replaced seven of the 90-deg. elbows. It was also shortened nearly one-

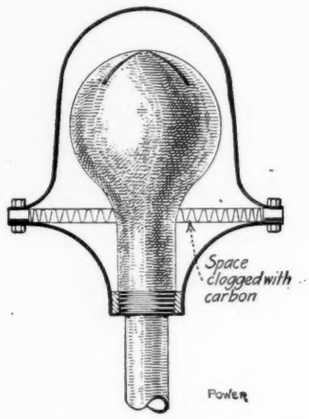


Fig. 1. Section through Muffler

half and where 2-in. pipe had been used in the first place 2½-in. pipe was substituted. The engine developed its full power after the changes were made and used no more fuel than before.

Gas engines, and particularly those of medium size, are sent out equipped with an exhaust vessel, usually of cast iron and with a capacity of three to five times the displacement of the engine cylinder. These are of great service in allowing the exhaust to drop to atmospheric pressure near the exhaust valve, but usually are not very effective as a silencer. One of the most satisfactory mufflers for medium-sized engines is a concrete box buried underground somewhere near the engine room and outside the building. These boxes have a capacity several times that of the engine cylinder, and are as a rule filled with broken rock. This breaks up the gases, yet gives them a chance to escape rapidly and without causing back pressure on the engine. The box is fitted with a manhole on which is placed a light cover, serving as a safety valve in case of an explosion of unburned gases in the muffler. A pipe is run from the box to the atmosphere, arranged so that it will drain out any water.

An installation similar to the foregoing had been installed in connection with a stationary engine and had been satisfactory for the several months it had been in service. The engine, after being started one morning and coming up to speed, suddenly stopped when the muffler cutout was closed, and it was found that the cylinder was filled with water. At first it was supposed that the gasket between the cylinder and the head was leaking, but it proved not to be. By referring to Fig. 2, it will be seen that the muffler is near the building and directly under the overhang of the roof where water could fall directly on the cover. During the night a heavy rain had fallen which had washed obstructions over the end of the outlet pipe near the muffler. Water had accumulated in the muffler and as the engine had a hit-

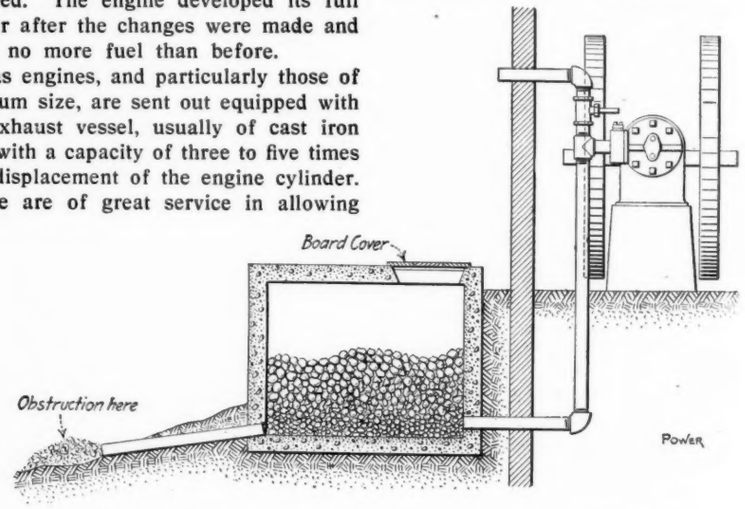


Fig. 2. Section through Muffler, Showing Obstruction

and-miss governor that governed by holding the exhaust valve open, the water had been sucked back into the cylinder the minute the engine had been thrown on the muffler. The water short-circuited the igniter and stopped the engine. In another case the same thing happened, due to water running down the exhaust pipe and filling the exhaust vessel while the engine was idle. An exhaust pipe

should be protected so that water cannot enter it. Trouble of the kind mentioned is not likely to happen to engines that do not govern by holding the exhaust valve open, but are constant compression engines or are throttle governed.

Many get into trouble through not allowing for expansion in the exhaust pipe. An engine was installed in the basement of a building and the 4-in. exhaust pipe run over to the wall and then up. No exhaust vessel was used and the 10-ft. length of pipe was run so near the wall that the elbow almost touched it when cold. Trouble was experienced in keeping the packing between the exhaust-valve casing and the cylinder tight; the expansion and contraction of the exhaust pipe being the cause of the trouble, which disappeared when the pipe was changed. A swing joint was placed in the pipe, which is perhaps the easiest way to provide for expansion and contraction in an exhaust pipe. Expansion joints cannot well be used on account of the difficulty in keeping the packing in good condition. The pipe is sometimes mounted on rollers where the arrangement is such that one end is free to come and go.

American Practice in Rating Internal Combustion Engines—V*

By T. C. Ulbricht and C. E. Torrence, Jr.

Efficiency Table for American Practice

One of the objects of this investigation was to derive an efficiency table for American practice similar to that derived some years ago by Güldner for German practice. Consequently, Table 4 was developed from the data given in the preceding articles of this series. This table contains the lower heat values, the actual and theoretical air supply, the British thermal units per cubic foot of mixture with different excess coefficients, the fuel consumption per rated brake horsepower-hour, and the thermal efficiency based on the brake horsepower for engines from 5 hp. up, for all the common gases and oil fuels used for power purposes.

The lower heat values per cubic foot and per pound are from the data given in Table 1 of Article III. However, in actual design it is unnecessary to use such exact values; for instance, instead of 589 B.t.u. per cu.ft. for carbureted water gas, 590 or 600 B.t.u. would be a sufficiently close approximation.

The columns on British thermal units per cubic foot of mixture marked with asterisks (*) show the excess coefficient of air generally used for best results. Under air required in cubic feet, actually,

*Copyrighted, August, 1912, by T. C. Ulbricht and C. E. Torrance, Jr.

TABLE 4

Fuel	Lower heat value B.t.u.-per		Air required in cu.ft.			B.t.u. per cu.ft. of Mixture with					Fuel consumption (e), (e′) and (e″) per rated b.hp.-hr. and thermal efficiency (e)																							
											5 b.hp.				10 b.hp.				25 b.hp.				50 b.hp.				100 b.hp.				Over-100b.hp.			
			Theoretically per		Actually per			Excess air																										
	Cu.ft	Lb.	Cu.ft of fuel	Lb. of fuel	Cu.ft. of fuel	Lb. of fuel	Theo ret. air	1.2	1.3	1.4	1.5	e	e′	e″	B.t.u.	e	e′	e″	B.t.u.	e	e′	e″	B.t.u.	e	e′	e″	B.t.u.	e	e′	e″	B.t.u.	e	e′	e″	e
									*	*			Cu. Ft.	Lb.			Cu. Ft.	Lb.			Cu. Ft.	Lb.			Cu. Ft.	Lb.			Cu. Ft.	Lb.			
Illuminating gas	304	....	2.63	....	3.0 to 4.0	....	83.8	73.2	68.8	64.8	61.5	14,300	47	....	17.8	13,100	43	....	19.4	11,550	38	....	22.0	10,600	35.2	....	23.8	10,160	33.4	....	25.0	10,160	33.4	....	25.0
(a) Water gas																																		
(b) Carbureted gas	589	....	6.84	....	7.50 to 12.00	....	75.1	63.9	59.5	55.7	52.3	14,300	24.3	....	17.8	13,100	22.2	....	19.4	11,550	19.6	....	22.0	10,600	18.1	....	23.8	10,160	17.2	....	25.0	10,160	17.2	....	25.0
(c) Coal gas	608	....	6.00	....			86.8	74.2	69.2	64.7	60.8	14,300	23.5	....	17.8	13,100	21.5	....	19.4	11,550	19.0	....	22.0	10,600	17.6	....	23.8	10,160	16.7	....	25.0	10,160	16.7	....	25.0
Producer gas					*																													
(a) Anthracite	125.7	....	1.053	....	1.0 to 1.5	....	61.3	55.4	53.	50.8	48.7	15,700	125	....	16.2	14,360	114	....	17.7	11,920	95	....	21.3	10,380	82.6	....	24.5	9,630	76.6	....	26.4	9,600	76.3	....	26.5
(b) Bituminous	125	....	1.120	....	1.0 to 1.5	....	59.0	53.4	50.8	48.7	46.6	15,700	126	....	16.2	14,360	115	....	17.7	11,920	95.5	....	21.3	10,380	83	....	24.5	9,630	77	....	26.4	9,600	76.7	....	26.5
(c) Coke	126.3	....	0.985	....	1.0 to 1.5	....	63.7	57.8	55.4	53.1	51.0	15,700	124	....	16.2	14,360	113	....	17.7	11,920	94.4	....	21.3	10,380	82	....	24.5	9,630	76.2	....	26.4	9,600	76	....	26.5
(d) Lignite	134	....	1.145	....	1.0 to 1.5	....	62.5	56.4	53.8	51.5	49.3	15,700	117	....	16.2	14,360	107	....	17.7	11,920	89	....	21.3	10,380	77.5	....	24.5	9,630	71.8	....	26.4	9,600	71.6	....	26.5
(e) Oil	151	....	0.990	....	1.0 to 1.5	....	75.9	69.0	66.0	63.2	60.7	15,700	104	....	16.2	14,360	95	....	17.7	11,920	79	....	21.3	10,380	68.7	....	24.5	9,630	63.7	....	26.4	9,600	63.5	....	26.5
(f) Peat	141	....	1.170	....	1.0 to 1.5	....	65.0	58.8	56.3	53.5	51.2	15,700	111	....	16.2	14,360	102	....	17.7	11,920	84.6	....	21.3	10,380	73.6	....	24.5	9,630	68.3	....	26.4	9,600	68	....	26.5
(g) Wood	128.7	....	1.070	....	1.0 to 1.5	....	62.2	56.3	53.8	51.5	49.4	15,700	122	....	16.2	14,360	112	....	17.7	11,920	92.7	....	21.3	10,380	80.6	....	24.5	9,630	74.8	....	26.4	9,600	74.6	....	26.5
Blast-furnace gas	95.2	....	0.735	....	1.0 to 1.3	....	54.8	50.5	48.6	46.8	45.2								22.4	11,150	117	....	22.8	10,860	114	....	23.4	10,500	110	....	24.2	9,860	104	....	25.8
Coke oven gas	487	....	4.76	....	7.15	....	84.5	72.4	67.8	63.5	59.8	14,300	29.4	....	17.8	13,100	26.9	....	19.4	11,550	23.8	....	22.0	10,600	22.0	....	23.8	10,160	20.9	....	25.0	10,160	20.9	....	25.0
Kerosene		18,755		189		260 to 380	86.3	79.7	74	69		16,300	....	0.87	15.6	15,500	....	0.826	16.4	14,370	....	0.766	17.7	13,900	..	0.74	18.3	13,800	..	0.736	18.4	....	..	..
Crude oil (Diesel)	....	18,636	....	187	.....	280 to 375	85.3	78.8	73.1	68.2	10,910	....	0.587	23.3	10,720	....	0.576	23.7	10,330	....	0.555	24.6	9,860	..	.528	25.8	9,380	..	0.503	27.1	9,320	..	.566	27.3
Gasoline	....	18,500	....	193.5	.....	250 to 350	85.2	78.8	73.2	68.2	15,900	....	0.86	16.0	14,120	....	0.763	18.0	12,520	....	0.677	20.3	....	..	....	..	....	..	....	..	....	..	....	..
Natural gas (av'g)	853	....	8.95	....	6.6–18*	....	85.7	72.7	67.5	63.	59.1	12,900	15.1	....	19.7	12,400	14.5	....	20.5	11,400	13.4	....	22.3	10,380	12.2	....	24.5	9,420	11.0	....	27	9,320	10.9	....	27.3
(a) High-hydro. gen	834	....	8.66	....	6.6–18*	....	86.3	73.1	68.5	63.5	59.5	12,900	15.5	....	19.7	12,400	14.9	....	20.5	11,400	13.7	....	22.3	10,380	12.4	....	24.5	9,420	11.3	....	27	9,320	11.2	....	27.3
(b) Low-hydro. gen	870	....	9.20	....	6.6–18*	....	85.2	72.4	67.1	62.7	58.8	12,900	14.8	....	19.7	12,400	14.1	....	20.5	11,400	13.1	....	22.3	10,380	11.9	..	24.5	9,420	10.8	....	27	9,320	10.7	....	27.3
Oil gas	542	....	4.94	....	7.15	....	91.2	78.4	73	68.4	64.4	14,300	26.4	....	17.8	13,100	24.2	....	19.4	11,550	21.3	....	22.0	10,600	19.7	..	23.8	10,160	18.8	....	25.0	10,160	18.8	....	25.0
Fuel oil	....	18,183	....	178	.....	250 to 350	102	85	78.5	73	68.2	16,300	....	0.897	15.6	15,500	....	0.852	16.4	14,370	....	0.79	17.7	13,900	..	.765	18.3	13,800	..	.758	18.4	....	..	..

the values representing average practice are also marked with asterisks.

The heat consumption in British thermal units per brake horsepower is found as follows for each case:

$$\frac{2545}{Thermal\ efficiency} = B.t.u.\ per\ b.hp.\text{-}hr.$$

The consumption of fuel in cubic feet per brake horsepower is found by dividing the British thermal units per brake horsepower by the British thermal units per cubic foot of fuel (lower heat value) as, for instance, for carbureted water gas,

$$\frac{14{,}300}{589} = 24.3\ cu.ft.$$

FUEL CONSUMPTION GUARANTEES

The following tabulations show the range in fuel consumption as guaranteed by American manufacturers for their engines with different fuels. In most cases the values are on the safe side, as actual tests show much lower results.

PRODUCER GAS

Full load—
9370 to 13,500 B.t.u. per b.hp.-hr.
15 to 18 cu.ft. of gas per b.hp.-hr.
1.12 to 1.25 lb. of coal as fired.
Three-quarter load—
11,000 to 13,000 B.t.u. per b.hp.-hr.
One-half load—
12,250 to 16,000 B.t.u. per b.hp.-hr.
One-quarter load—
17,000 B.t.u. and upward per b.hp.-hr.

NATURAL GAS

Full load—
8000 to 15,300 B.t.u. per b.hp.-hr.
10 to 18 cu.ft. of gas per b.hp.-hr.
Three-quarter load—
10,700 to 12,000 B.t.u. per b.hp.-hr.
One-half load—
12,250 to 16,000 B.t.u. per b.hp.-hr.
One-quarter load—
17,000 B.t.u. per b.hp.-hr. and upward.

ILLUMINATING GAS

Full load—
10,000 to 13,800 B.t.u. per b.hp.-hr.
15 to 20 cu.ft. of gas per b.hp.-hr.
Three-quarter load—
11,000 to 12,000 B.t.u. per b.hp.-hr.
One-half load—
13,000 to 16,000 B.t.u. per b.hp.-hr.

BLAST FURNACE GAS

Full load—
10,500 B.t.u. per b.hp.-hr.
Three-quarter load—
11,500 B.t.u. per b.hp.-hr.
One-half load—
13,600 B.t.u. per b.hp.-hr.

KEROSENE

Full load—
13,240 to 16,150 B.t.u. per b.hp.-hr.
0.1 gal., or 0.75 to 0.84 lb. per b.hp.-hr. for small engines.
0.56 to 0.65 lb., or 0.725 to 0.901 pints per b.hp.-hr. for large engines.

GASOLINE

Full load—
10,820 to 15,500 B.t.u. per b.hp.-hr.
⅛ to ⅒ gal. per b.hp.-hr.
0.586 to 0.968 lb. per b.hp.-hr.
0.8 to 1.1 pints per b.hp.-hr.

FUEL OILS

Full load—
8720 to 13,320 B.t.u. per b.hp.-hr.
0.1 to 0.128 gal. per b.hp.-hr.
0.393 to 0.74 lb. per b.hp.-hr.
1 pint (average) per b.hp.-hr.

FUEL OILS FOR AMERICAN DIESEL ENGINES

Full load—
9029 to 11,200 B.t.u. per b.hp.-hr.
0.0608 to 0.0784 gal. per b.hp.-hr.
0.447 to 0.588 lb. per b.hp.-hr.

A Jacket Water Trouble and Its Cure

BY A. D. WILLIAMS

A newly installed 300-hp. gas engine gave considerable trouble. The cylinders were vertical and the jacket water entered the bottom of the jackets, then passed up to the cylinder head, thence to the exhaust valves and the jacket surrounding the connection to the exhaust manifold. Some of the water passed to the exhaust gas spray and the rest returned to a sump, from which it was pumped to a cooling tower. This method of circulation brought the coolest water around the lower part of the cylinder, and though the cylinder had been bored with a slight taper to compensate for contraction at this point, it was found that the piston had some tendency to seize at the bottom of its stroke, and required excessive lubrication.

The engine had a fairly constant load and was operated 24 hours a day, seven days a week. The continuous operation gave ample time for the engine to get heated up all over and no shutdown periods allowed opportunity to cool off. It was found, however, that the machine could not be held to the continuous schedule, but had to be shut down frequently to provide cooling periods.

One of the troubles was a tendency of the cylinder-head jackets to become vapor bound; hence it was found necessary to vent them. The exhaust outlets and the jacket water got exceedingly hot. The upper part of the cylinder and the top head became so hot that to touch them burnt the hand. Some slight exhaust-valve troubles, due to overheating, were also experienced.

The engineer in charge suggested that reversing the cooling-water circulation would reduce the trouble. The builders of the engine were dubious, but agreed to make the change without charge provided the plant would pay the cost of restoring the old system if the one suggested proved inoperative. The change consisted in removing the waste-water manifold from below the exhaust outlets and connecting the cooling-water supply at this point; while the old cooling-water connections to the bottom of the cylinder jackets were replaced by a waste-water manifold. The waste line from this manifold was run with an inverted "U" in it and connected to a pipe leading to the cooling-water sump. This inverted "U" was made high enough to maintain about 1½ in. of water on top of the upper cylinder head and a vacuum breaker was placed at its highest point to prevent this water siphoning out when the supply was cut off.

With the new system of circulation the cool water becomes warmed in the exhaust-outlet jackets and causes a large drop in the temperature of the exhaust gases with a reduction in the amount of water required to be injected into the exhaust manifold. The water on the top of the cylinder head and in the cylinder jackets has a gradually increasing temperature, and there are no marked differences in temperature, such as occurred when the cool water entered the cylinder jacket. The consumption of cylinder oil is considerably reduced and the piston no longer tends to seize. Runs of several weeks' duration are now frequently made with this engine.

CORRESPONDENCE

Piston Rings Caused Trouble

Our 15x14-in., three-cylinder, vertical, producer-gas engine had been giving trouble by the governor hunting and jumping at all loads. The engine had been in use about two years, running on an average of 6 hr. a night and during this time the pistons had not been removed; consequently the rings were in bad condition, causing a loss of compression as the indicator diagrams showed. At first we did not connect this with the actions of the governor, but after going all over the governor bearings, taking up all lost motion, setting the valves and timing the ignition, without any relief, we decided to remove the pistons, taking one out each night after shutting down. A slight improvement was noticed after the first piston had been cleaned and replaced, which encouraged the work of removing the others, and, after they had all been overhauled, the engine settled down to its usual satisfactory performance.

This happened about 18 months ago, and recently the engine began to act in the same manner, namely, loss of compression coincident with the governor hunting. Therefore we again removed the pistons, cleaned the rings, putting in new rings for those that appeared worn, and now the engine is again running as it should and carries its full load.

J. W. FRIES.

Middleboro, Mass.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Combined Central Heating and Electric Plants*

By Edwin D. Dreyfus

Operating a heating plant singly is only attractive under favorable circumstances. Electric stations, operating independently, are successful in most cases; but by effectively combining the two, very fair returns should accrue. This paper aims to present some new developments in prime movers, more particularly in the steam-turbine field, whereby improvement in efficiency of the consolidated electric steam-heating plant may be effected.

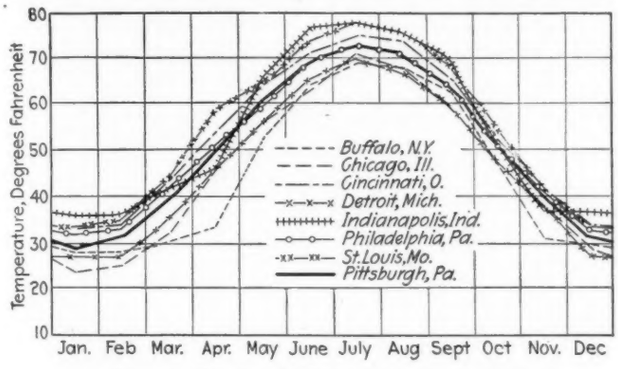


Fig. 1. Monthly Temperature Curves

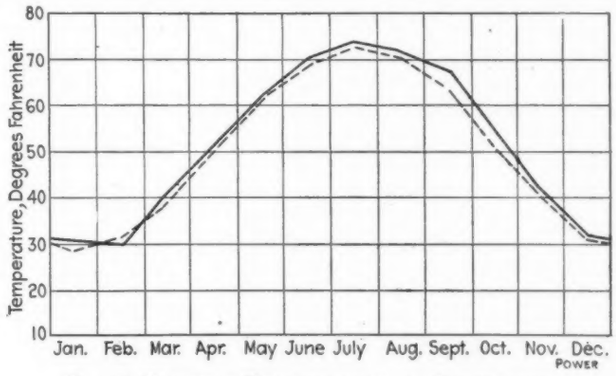


Fig. 2. Monthly Temperatures at Pittsburgh

shown by the dotted line, while a 20-year average for Pittsburgh is represented by the heavy line. The analysis of these conditions is not complete. Effects of not only daily changes, but the hourly variations as well, must be properly examined. Hence the records of the U. S. Weather Bureau at Pittsburgh have been consulted, and 20-year averages have been plotted in Fig. 3.

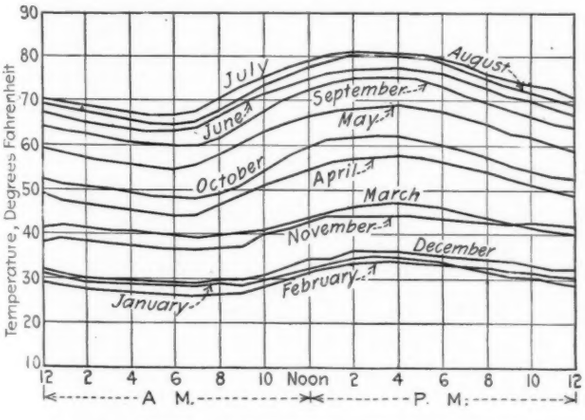


Fig. 3. Hourly Atmospheric Temperatures at Pittsburgh

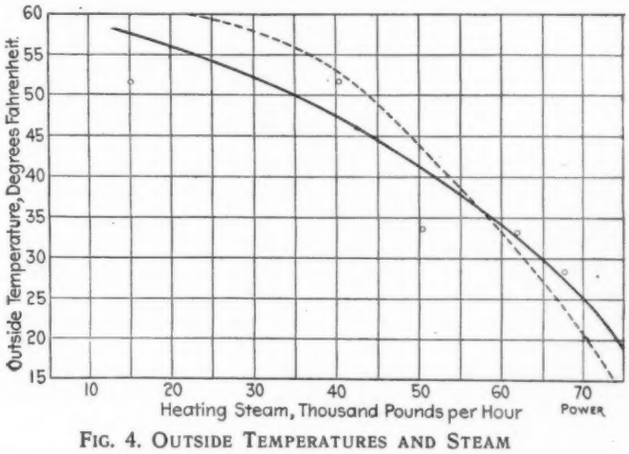


Fig. 4. Outside Temperatures and Steam Requirements

Temperature Factors

As the paper is concerned principally with heating requirements, a study of the seasonal, daily and hourly variations in temperature in some typical latitude where a heating plant may be installed is important. The monthly temperature for the year from the U. S. Signal Service and Blodget's Climatology for eight first-class cities of this country are reproduced in Fig. 1. Pittsburgh's climatic conditions, excepting possibly a small difference of humidity, proves to be a fair average between latitudes 38 and 43 deg., which embrace the territory investigated. This is shown more clearly in Fig. 2, where the average of all these curves is shown by the dotted line, while a 20-year average for Pittsburgh is represented by the heavy line. The analysis of these conditions is not complete. Effects of not only daily changes, but the hourly variations as well, must be properly examined. Hence the records of the U. S. Weather Bureau at Pittsburgh have been consulted, and 20-year averages have been plotted in Fig. 3.

Steam Consumption

As the exhaust-steam demand through the year will depend upon the extent and character of the heating system, it is unsafe to generalize. A specific example should be followed, and therefore an assumed station has been laid out to contain three 1000-kw. automatic bleeder turbines and two 1000-kw. standard condensing turbines. This station is intended to serve a maximum average heating demand of 65,000 lb. of steam per hour, and an electric peak of 4600 kw. These demands occur during different months of the year, the high electrical peak in December, and the greatest heating consumption in February. The ratio of the maximum kilowatts to heating steam demand of the plant is 1 to 14.2. The conditions apply approximately to a city of about 80,000 to 100,000 population.

The hourly steam consumption for different outside temperatures (standard inside room temperature of 70 deg. F. understood) is arrived at empirically from available data, as given in Fig. 4. The dotted curve is derived from a curve given by F. C. Chambers in the proceed-

*Abstract of a paper read before the National District Heating Association at Detroit.

ings of the National District Heating Association for 1911. The circles represent points given by a 6000-kw. central station in Illinois. The full line represents an average curve assumed for the accompanying calculations.

As the outside temperature decreases and the steam consumption in the heating system changes correspondingly, the pressure at delivery from the power house must be raised to overcome the friction losses and effect of condensation which increases as the demand becomes greater. A schedule of pressure is usually es-

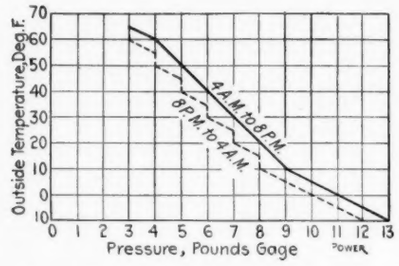


FIG. 5. TEMPERATURE-PRESSURE CHART FOR PARTICULAR SYSTEM

tablished, and the curves in Fig. 5 will indicate suitably the proportionate pressures that should exist at the outgoing feeders from the power house for different outside temperatures. These figures are somewhat arbitrary, as obviously the absolute pressures in any case will

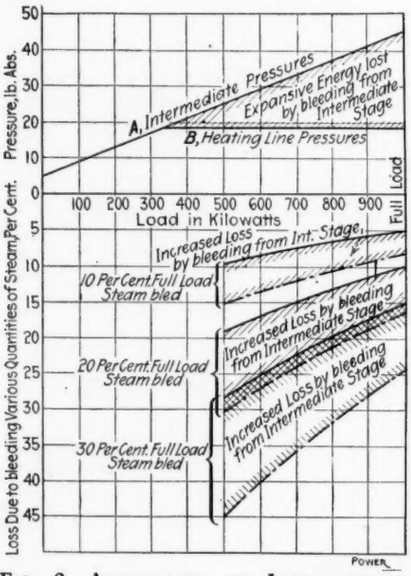


FIG. 6. ADVANTAGES OF LOW-PRESSURE OVER INTERMEDIATE-PRESSURE BLEEDING

depend upon the size of mains used and their length or lineal equivalent.

TYPES OF PRIME MOVER

Where the heating demand was a large factor, reciprocating engines have been used principally. They have been simple or compound noncondensing, compound condensing with provision for bleeding from the receiver, or else the plant has been a combination of these types to produce the best results for existing conditions. Compound reciprocating engines with moderate cylinder ratios, have been often selected so that the engine may run alternately condensing or noncondensing as the demands may dictate, but Fig. 7 makes plain that a large loss of economy will occur during the nonheating seasons, as well as during times of light heat demand. Noncondensing steam turbines have been installed in a few cases, as well as condensing steam turbines where steam has been bled from the intermediate stage.

Within the last two years a special turbine has been devised in which the steam not bled is automatically diverted to the low-pressure section. The earlier types of engines and turbines are already well understood. The construction of the new Parsons' machine closely resembles a standard condensing turbine, the main departure being locating a diaphragm between the intermediate- and low-pressure stages; the flow of steam is regulated by a gravity controlled valve.

In the summer months when no exhaust steam is demanded the bleeder valve may be lifted entirely out of the zone of action. In some installations bleeding all the steam from the turbine for extended periods may be desirable. If the turbine is fairly well loaded, as it would probably be under these circumstances, having the steam pass through the entire turbine would prove more economical if none escapes to the atmosphere. This would be accomplished by piping arranged so that the condenser could be cut out and the entire exhaust from the turbine directed into the heating system.

At times of brief heavy peaks in the electric load, a special device attached to the turbine can be used to automatically disconnect it from the heating system, allowing it to operate strictly condensing and thereby develop its maximum power.

BLEEDING AT LOW AND INTERMEDIATE PRESSURES

The distribution of work throughout a turbine is divided roughly as two-tenths in the high-pressure, three-tenths in the intermediate-, and five-tenths in the low-pressure section. This shows the significance of expanding the steam through the intermediate section before utilizing it in a heating system. The advantage derived is shown graphically in Fig. 6, the upper portion of which indicates the pressure variation at the entrance of the intermediate section. With the bleeder connection at this point, considerable throttling losses occur, as will be appreciated from lines *A* and *B* representing the pressure at the latter section and the heating system respectively.

For every pound of steam bled, expansive energy will be lost correspond-

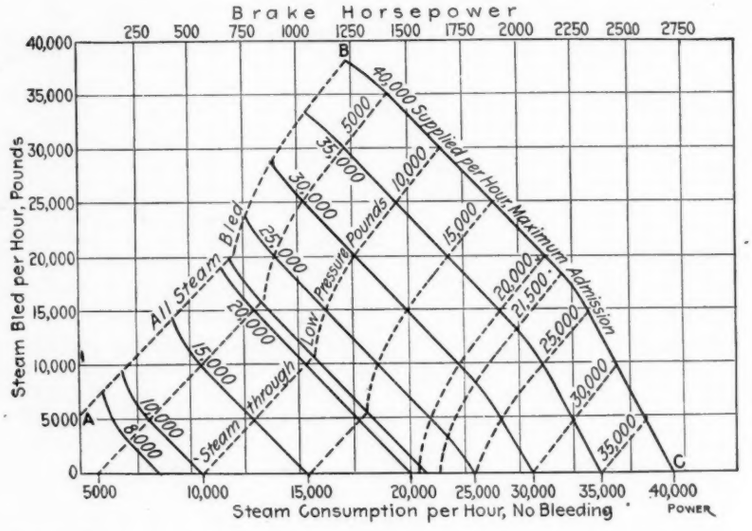


FIG. 7. RELATION OF STEAM DISTRIBUTION AND POWER LOAD WITH VARIABLE BLEEDING DEMAND

ing to the pressure drop from the intermediate section to the exhaust. Expanding the steam throughout this section before bleeding will correspondingly reduce the energy loss, the amount being equivalent to the additional work performed. The large drop in pressure occurring in the high-pressure stage does not indicate that this section is doing a proportionate share of the work as the heat drop through high-pressure ranges is far less than through the same range at lower pressure.

The lower set of curves, Fig. 6, compares the loss in capacity which would be caused by the two bleeding systems for varying percentages of steam bled, assuming an equal amount of steam passing through each turbine. The quantity of heat per pound theoretically lost by cutting short the expansion at the intermediate pressures determined by the

pressure-load line *A*, has been computed and expressed on a percentage basis for different amounts of steam bled. Values thus obtained are shown by dotted lines, the solid lines representing losses that occur with the improved method of bleeding from the low-pressure section. Evidently, therefore, the vertical distance between curves corresponding to equal bleeding demand, closely approximates the saving affected by a bleeding arrangement utilizing steam at low, rather than at intermediate pressure. Besides being more economical, low-pressure bleeding permits operating the heating system with the overload valve of the turbine open.

Characteristics of Automatic Bleeder Turbine

As the performance of the automatic bleeder must be known to appreciate the work in the continuation of the study or examination of the specific case undertaken, the characteristics of such a turbine are illustrated and discussed at some length. The triangular chart, Fig. 7, enables a ready comprehension of the relation between the steam bled, steam supplied to the turbine (that is, draft on the boiler) and the quantity passed to the condenser for a given power load sustained by the unit. These curves have been plotted against brake horsepower on the horizontal, and weight of steam on the vertical scale. The solid lines extending up and to the left, are lines of constant steam supply and show the increase of available power with decreased bleeding. As will be observed, this is a straight line relation within certain ranges, the power output increasing at a constant rate as the amount passing through the low-pressure stages increases, as shown by the dotted lines which extend up and to the right. As the latter reach a certain value, i.e., about 21,500 lb., the slope of both the solid and dotted lines becomes steeper and correspondingly the rate of increase of power output is diminished. This is due to the secondary overload valve opening, as the turbine is designed for a normal bleeding demand and the low-pressure stages are accordingly proportioned to pass a certain quantity of steam and, therefore, when this is exceeded, the turbine output while still increasing, does not increase at so fast a rate.

To complete the exposition, a supplementary scale has been added besides that of the brake horsepower which gives at a glance the total steam consumption of the unit operated strictly condensing (a limiting condition). The other two interesting limits are lines *AB* and *BC*. The first gives total steam with no work developed in the low-pressure cylinder. Line *BC* establishes a boundary for maximum power which may be developed when a predetermined amount of steam is bled. When all steam is bled, as shown by the limiting line *AB*, the total amount supplied is slightly greater than that accounted for by the quantity bled. On first thought these should be equal, but owing to the construction employed, a little steam leaks past the packing into the low-pressure section, which explains the apparent discrepancy.

The curves shown in Fig. 7 are for one set of steam conditions only, 150 lb. initial pressure, dry and saturated, 5-lb. gage bleeding pressure and 28-in. (30 in. bar.) vacuum at the turbine exhaust. These particular curves apply to the turbine intended where the steam would always be bled in large quantities, and, therefore, contains only a relatively small low-pressure wheel. Where conditions require it, the automatic bleeder turbine may be made equally as efficient in operation as the standard designs of complete expansion turbines.

Working Results

With the character of the steam and heating loads laid down, and the performance of the different units ascertained, the results for each progressive month may be developed. In deriving the final curves, Fig. 9, an average curve sheet for each month was prepared, such as the one shown in Fig. 8. To keep the related curves together, the average hourly temperatures were transferred from Fig. 3 and the steam required for heating during the day, from Fig. 4. The average hourly steam required is obtained from Fig. 4, and the variations occurring from hour to hour are interpolated from the previous data. The curves of the average day of the month have been made, in the twelve conditions introduced, to correspond with the typical monthly difference throughout the year.

The total capacity of the units in service is shown by the stepped-lines. The units in operation, whether engine or turbine equipment, are scheduled on these average daily sheets; this was planned so that no hasty cutting in or out of different types would be necessary if the load swung widely from the normal. Furthermore, ordinarily the load surges appreciably so that the curve of output is quite irregular instead of smooth as represented. The use of the smooth curve is permissible, however, to facilitate working out the final quantities, if proper regard of the deviations is taken when connecting or disconnecting the units from the busbars.

Taking the loads and the steam demands and referring back to the original data, the various points on the final steam-consumption curve were determined.

The monthly curve sheets show that for a few hours in the early morning the power load is so light that live steam must be bled to the heating main. This live steam is taken as part of the plant consumption, and is included in the total steam curves in Fig. 9.

According to the curve in Fig. 4 no heating steam would be demanded when the outside temperature reached about

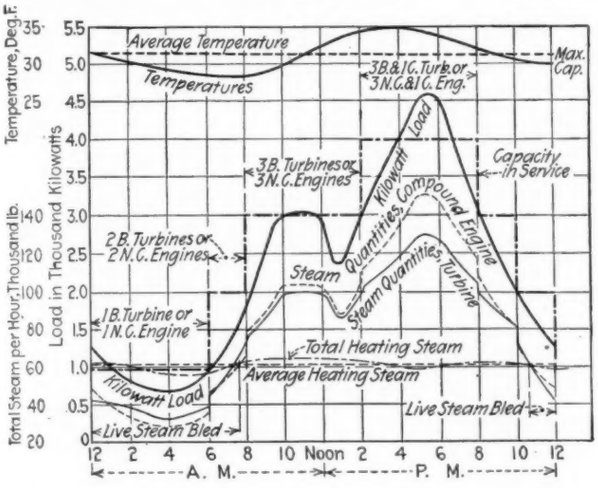


Fig. 8. Mean January Demand—Load Factor 40.4 per Cent.; Total Kw.-hr., 1,380,000

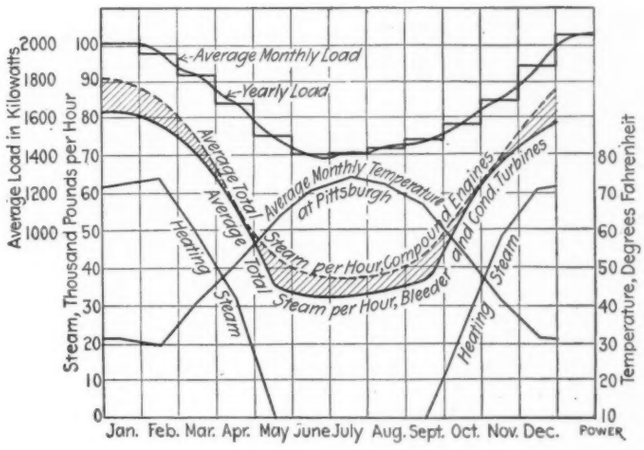

Average Load in Kilowatts
Average Monthly Load
Yearly Load
Average Total Steam per Hour, Compound Engines and Cond. Turbines
Average Monthly Temperature at Pittsburgh
Heating Steam
Average Total Steam per Hour, Bleeder
Heating Steam
Steam, Thousand Pounds per Hour
Temperature, Degrees Fahrenheit
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
POWER

Fig. 9. Summary Curves

60 deg., and since the average monthly temperatures of May and September are more than 60 deg., no heating requirement is shown for these months. Evidently, however, during part of these months some steam would be required, and hence the value of the total steam for these two months has been increased slightly when transferred to Fig. 9. This final curve sheet, shows graphically that the automatic bleeder turbine plant follows the heating-steam requirement curve more closely than the compound-engine plant, indicating about 10.6 per cent. less steam used per year by the bleeder turbine equipment than by the piston-engine plant. It is not claimed that this comparison is by any means absolute, but practical operation will undoubtedly bear it out as a general proposition.

CORRESPONDENCE

Mr. Jahnke's Heating Coil

It is difficult to understand how the 150-ft. wall coil, shown by H. A. Jahnke in the June 11 issue (Fig. 1), even remained on the wall plates when steam was turned on unless the pipe header shown at the right was so arranged that it would allow for expansion. A pipe coil of the length stated will expand a considerable distance, and, as in most long coils the upper pipes will heat up before the lower ones, ample provision should be made to allow each pipe to expand independently of the others; otherwise the cast-iron headers will likely be broken by the unequal expansion.

The pipes may also buckle so much that the coil will lift in parts from the hook plates, or if inclosed hangers are used, will probably be torn from the wall supports.

The plan shown in Fig. 2 is good only for a coil about 200 ft. long. The turn shown at one end should be at least 3 ft. long at the short side of the turned pipes. If there is not room overhead for a long turn, it can be made around a corner of the room.

Some steam fitters claim that the turn around a corner has the advantage over the upper turn, for, in a long coil, as in Fig. 2, when steam is turned on, the expansion may increase the length of the pipes several inches. If little steam is admitted the upper pipes will heat first and, as they lengthen, the elbow of one pipe will reach the next one to it and, as the last pipe mentioned may be cold and rigid, the pressure of the hot pipe against it may be great enough to crack the elbow.

In a coil 200 ft. long it is good practice to have a turn at each end. At the feed end there should be an upper turn, as shown in Fig. 2, and at the drip end, a corner, or down turn. This would allow the pipes to move both ways and the strain upon them and the headers would be greatly decreased as compared with that shown in Fig. 2 of Mr. Jahnke's letter.

JAMES E. NOBLE.

London Junction, Ont.

Mr. Jahnke's Fig. 1 in the June 11 number is surely a bad installation. Any heating coil installed should be mitered either on the supply or return end and better still on both ends when the coil is 100 ft. long or over. I do not think two steam manifolds necessary for the system in question, but would suggest that at least one end be mitered and that steam be introduced at each end of the supply manifold.

A short time ago I installed a heating system in which one coil had nine 1¼-in. pipes 225 ft. long. The supply manifold received steam at each end and the return end was mitered. The results from the system are entirely satisfactory.

R. G. COX.

Harrisburg, Penn.

From my experience I think the proposed coil shown in Fig. 2 is good practice, considering its location and use. There should, however, be swinging, or swivel connections and valves at both inlet and outlet to the coil. This swinging connection alleviates any strain that might be brought upon the coil by the expansion and contraction of the supply and return pipes.

M. C. ST. JOHN.

Houston, Tex.

Mechanics of Heating and Ventilating

In the review of my book on "Mechanics of Heating and Ventilating," which appeared in the June 11 issue, it is claimed that nothing is said about arranging the piping to balance distance as well as the friction heads. The distance is taken into account in all problems. While not always specially mentioned, the ways and means of allowing for length are really self-evident. The example for forced hot water shows a case with distances of about 1500 ft. each way.

Regarding the relation of the static head with reference to the height of the expansion tank, I think that when the tank connections are properly placed and sized, and the suction head is kept well below the static head, there will be no trouble with an open tank.

The apparent errors quoted for the differential heads 70.8 and 83.8 arise from the fact that the last decimals of the densities from which they were figured had been omitted in the test. In any event, the discrepancies are within the variations of different data on the properties of water. They would make less than 1 per cent. difference on the differential head and be of no consequence at all in equalizing a system.

My statement on omitting reducing valves was given more as a theoretical possibility, and refers only to the transmission of live steam at high-pressure drop, not to exhaust heating.

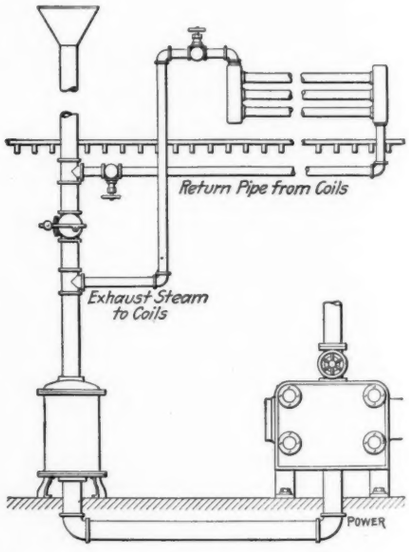
The pressure drop of 6 to 12 lb. per sq.ft. will give slightly larger mains than are used by most engineers, but this in my opinion is desirable, all things considered. If equilization is carried fairly close, there is no reason why a larger drop cannot be assumed. It is all a matter of judgment, depending on the situation.

K. MEIER.

New York City.

Expert Piping

The accompanying sketch shows how the condensation from a back-pressure heating system is to be returned to the exhaust pipe, above the back-pressure valve, unless the engineer, in charge of the plant, succeeds in presenting a more convincing argument than a plain statement of facts and principles, to the "expert" installing the system, and the owner blindly allowing the expert full authority.



NOVEL CONNECTION OF HEATING COIL

So positive is the owner that the exhaust will merely be bypassed through several hundred feet of heating coils and return to the exhaust pipe without any change in its condition, that, should he discover the engineer seeking to enlist outside interference, he would possibly discharge him. Before risking his reputation in operating such a system, the engineer would like the opinion of readers on the proposed piping, and what course they would suggest to convince the owner of the fallacy of the idea.

R. ESSINGER.

Nahant, Mass.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

FRED R. LOW, Editor.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, December 20, 1910, at the post office at New York, New York, under the Act of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue 30,000 copies are printed.

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	Page
Running a Steam Turbine	248
Distortion of Indicator Drum Motion	252
Replacing Boilers and Engines	255
Single and Twin Filter and Grease Extractors	256
Williams Improved Flue Gas Apparatus	256
Purchased Current for Summer Service	257
Faulty Separator Trap Connection	257
Ground Detector for High Tension Circuits	258
Synchronous Motor-Generator	258
Wattmeter Problem	259
What Made Transformers Heat?	259
Exhaust Piping	260
American Practice in Rating Internal Combustion Engines—V	261
A Jacket Water Trouble and Its Cure	262
Piston Rings Caused Trouble	262
Combined Central Heating and Electric Plants	263
Mr. Jahnke's Heating Coil	266
Mechanics of Heating and Ventilating	266
Expert Piping	266
Editorials	267-268
Readers with Something to Say: Water-Sealed Flue Gas Collector....State License Laws....Bypassing the Draft in a Blower System....Home-Made Devices for the Plant....Steam Pipe Peculiarly Obstructed....A Handy Home-Made Water Sprinkler....Repairs to a Gridiron Valve Gear....Criticise These Diagrams	269-271
Questions Before the House: Correctives for Fluctuating Water Level....Mr. Haight's Engine Trouble....Why This Peculiar Exhaust?....Is the Packing Defective?....Cleanliness and Mechanical Efficiency....Modern Pumping Plant....Electrolysis Pipe Corrision Doubted	272-274
Inquiries of General Interest	275
Study Questions	276
Power Gas from Coal Seams	276
Confessions of an Engineer	277
Emergency Piston Repair	278
Stone Boiler Setting	279
Saving the Returns	279
Old Centennial Boilers	280
Square End Pipe Cutter	280
Elevator Guide Lubricator	280
Komo Steam Trap	280
Dourte Valveless Pump	281
Home-made Automatic Engine Stop	282

POWER

Purchased Current For Summer Service

Elsewhere in this issue we print the arguments of W. A. Blonck, of Chicago, who endeavors to convince the office-building owner that it would be cheaper to shut down his plant during the summer months and purchase electrical energy from the central station. He at the same time concedes that during the heating season the operation of the isolated plant is the more economical.

If such a course were feasible we should gladly commend it; for not only are we solicitous as to the welfare of the engineer, but we also want to see the owner run his plant as cheaply as possible consistent with efficiency and good service. Mr. Blonck's arguments, however, although attractive at first glance, prove very superficial upon analysis.

In the first place, if the plant were run on central-station service during the summer months, it would necessitate electric elevators and all motor-driven pumps and auxiliaries. Doubtless very few office buildings are thus equipped and to change over would incur considerable expense. Also with all electric-driven auxiliaries a profitable source of exhaust steam for feed-water heating during the winter months would be removed, and this exhaust steam would have to be taken from the main engines at the expense of the heating system. Moreover, many buildings are fitted with absorption refrigerating systems which require exhaust steam during the summer.

As for the labor, it would be poor policy for any management to break up the personnel of its operating force during the summer season. This would tend to less efficient service and consequently higher cost of operation during the heating season. On the other hand, if left intact it would mean a large labor item which must be charged against the summer service. Furthermore, not only must the labor be thus charged but the interest, depreciation, taxes, insurance, etc., on the idle equipment must be likewise charged against the purchased current. It is doubtful if current could be purchased so cheaply, under a short-term contract, with these additional charges as to make the total cost of summer service less than when operating the isolated plant.

Turning now to the central-station viewpoint, it is questionable whether any central station would care to enter extensively into this class of service without charging a rate commensurate with the conditions, unless on the chance that having once obtained the customer for a five months' contract, and thus secured a foothold, it would be easy to induce the owner to use central-station service altogether.

Two Kinds of Engineers

Assurance, self-confidence and a general belief in his ability and knowledge to do things are strong assets to an engineer, when they are justified. Such men, if not overburdened with egotism, make valuable acquaintances, especially if disposed to impart their knowledge to others.

Not uncommonly, a man well informed on some particular subject more or less interesting to other engineers, refuses to impart any of his information, taking the stand that, as he had to dig for what he knows, others can do the same. This is a questionable policy. A selfish man seldom accomplishes much or attains to high regard.

At the other extreme is the engineer who thinks he knows much more than he really does and is prodigal with his advice. When an engineer reaches the stage that he cannot admit anyone is right who differs with him, disputes everything that does not coincide with his experience, however limited that may be, and insists on his opinions against all argument or reasoning, he becomes an unmitigated bore.

Fortunately, few engineers belong to either of these classes. Most of them are glad to share the benefit of any information they possess and have respect for

the views held by others. Both attitudes are evidences of broad-mindedness, and that is one of the characteristics of the truly great.

Massachusetts Boiler Law

That the provision made for considering changes in the Massachusetts Boiler Rules twice annually, was wise cannot be gainsaid. Advantage has been taken of this provision a number of times, and it has relieved many situations that were embarrassing to both the boiler manufacturers and those interested in the just enforcement of the rules. It appears from recent developments that some changes in the law itself are advisable.

The recent resignation of the chief inspector of the department developed the fact that no provision had been made for such a contingency and a successor could not be appointed; but this was a matter that affected the department alone. A more serious condition has been recently developed which affects the right of an inspector to earn his living. A company writing boiler insurance in the State of Massachusetts, recently dropped that line and had its business taken over by another company, which necessitated disbanding its boiler-inspection force. The company going out of business had in its employ an inspector who only a very short time before had passed an examination and secured a certificate of competency. This inspector was now out of a job, but having received the stamp of approval of the Massachusetts authorities, his services were naturally in demand, and another company engaged in the same line of business employed him.

The Massachusetts law provides that an inspector's certificate is automatically revoked when he ceases to be employed by the company that employed him at the time of making application for the certificate; so this inspector had no certificate of competency, but there appeared to be no reason why a new one could not be obtained. However, when application was made, the information was received that ninety days must elapse between two examinations to comply with the law. This is certainly a great injustice to a man who earns his living by inspection work, and we believe it will be found unconstitutional to deprive a man of his rights in such manner. Why should not an inspector holding a certificate of competency have it transferred without further examination if he should desire to become employed by a different insurance company?

What chance has an inspector in Massachusetts to better his condition? If he seeks a more remunerative position with another company he must first forfeit the certificate of competency which he holds and stand another examination. If he should fail he would be without means of obtaining work as an inspector at all, and could not even return to his former position. Such conditions as these need prompt attention if the Massachusetts Boiler Laws are to continue their successful start.

Excess Air Indicated by Superheat

With a correctly designed furnace and proper firing, complete combustion depends almost entirely upon the control of the air supply. This is now recognized as fundamental. When using oil fuel this regulation, for obvious reasons, is much easier than when burning coal. In either case the temperature and composition of the flue gases are usually depended upon to indicate whether too much or too little air is admitted.

We understand, however, that during some tests on one of the large oil-burning plants on the Pacific Coast an entirely different method was employed to ascertain the proper amount of air. It was discovered during the preliminary tests that too much excess air was invariably accompanied by an increase in the superheat, whereas an inadequate supply was indicated by a decrease in the degrees of superheat. While this puzzled the engineers at first it was finally explained as follows:

The boilers were of the B. & W. type and with an excess of air the furnace temperature was lowered and consequently less heat was absorbed by the first pass. This being true the temperature of the gases passing the superheater were higher and more heat was absorbed by the superheater.

This means of indicating the proper air supply was found to work so satisfactorily that it was depended upon to a large extent throughout the tests. While local conditions may have favored this way of indicating the air supply, still it is reasonable to assume that it could be employed in other cases. It is simple and its general reliability is worth investigating.

Precautions against Damage from Tube Failure

As has been stated many times in these columns, the only legitimate excuse for boiler laws and the licensing of engineers is the duty which devolves upon the government to adopt and enforce such safeguards as may reasonably be expected to protect the public or those concerned with the operation of steam plants.

One of the simpler devices that affords considerable protection to the attendant, where a water-tube boiler is used, but which is rarely adopted, is the inward opening fire-door. Tube failures in water-tube boilers are of daily occurrence, and while it behooves the insurance interests as well as municipal and state authorities to investigate and see if the number of such failures cannot be reduced, there is little likelihood of the problem being thoroughly solved in the near future; in the meantime life, limb and property are being sacrificed in such accidents.

Inward opening fire-doors will not prevent serious or fatal results in all cases of tube failures but are likely to in the majority of such accidents.

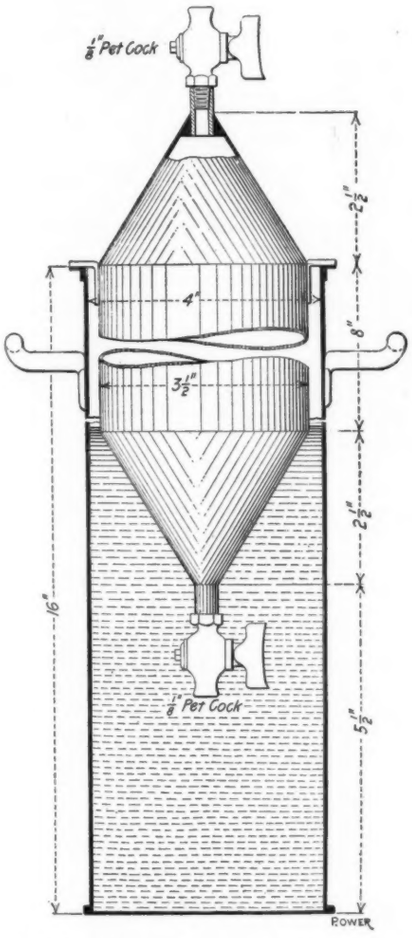
Not often is the brickwork disturbed by these accidents; but the fire-doors are usually blown open, and if the fireman happens to be in his accustomed place, directly in front of the boiler, he is either burned by flying coals or escaping steam, or inhales flame, and this nearly always is fatal. POWER is constantly striving to be of benefit to the power-plant operative, and we would advise every engineer employed where water-tube boilers are used to endeavor to persuade the owner to equip them with doors which will not fly open when a tube bursts. Every fireman, because he is the one most vitally interested, should insist that his engineer urge this safeguard. POWER advises adopting such rules as are necessary to procure these devices for use in water-tube boilers, in states or municipalities having enacted or contemplating the enactment of laws governing the operation of boilers.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Water-Sealed Flue-Gas Collector

The flue-gas sampler illustrated is made of light galvanized iron riveted together, soldered at the joints, and may be of any convenient size. The handles on the side of the open cylinder allow hanging it up if it cannot be set down.



WATER-SEALED FLUE-GAS COLLECTOR

If the closed cylinder is placed in the open one, as shown, and the water run out, it will cover the lower cock, acting as a water seal preventing air from entering the collector if it is not removed instantly. If a sample over several hours is desired (three hours being the practical limit for the size shown), the cocks should be adjusted at intervals, for when the water flows out, the pressure is reduced, decreasing the amount of flow, thereby sucking in more gas during the first periods than the last.

If the collector is connected to the flue by a short piece of rubber tubing, it can be easily removed and carried to wherever the Orsat apparatus is situated.

C. L. BARNUM.

West New Brighton, N. Y.

State License Laws

I have read with interest the articles in POWER from time to time relative to state engineers' license laws. I hold an engineer's license and believe that every engineer should be required to pass an examination based on years of practical experience as well as technical education before he is intrusted with the responsibilities of operating a plant, the number of years experience varying according to the class of license he procures. However, I do not believe an engineers' license law is needed, particularly in this state, as badly as a state boiler-inspection law. This has been brought more forcibly to my mind since I took charge of the plant I am now operating.

To save the expense of a boiler plant and also of rehandling coal, a local plant erected its engine room near a coal mine and receives steam from the boilers that operate the mine. The coal company is paid for the steam used. In the mine boiler house are four 72-in. and two 60-in. boilers, 16 ft. and 18 ft. long, respectively, set up in large sandstone rocks and lined inside with ordinary red brick; all are in bad shape. They are all half-flush front boilers with the iron fronts cracked in several places, and most of the brick lining is gone.

The management refuses to use glass water gages and for gage-cocks ordinary pet-cocks and ½-in. globe valves are used which either fail to work at all, or blow all the time. Each boiler is fitted with a steam gage, but no two register alike and none are correct. The flues are so scaled inside and out, and so corroded that every few days some need rolling. This has been done so often that the flues in some of the boilers are almost as thin as paper.

Most engineers agree that a boiler-inspection law would help them in their work. As I have to be on duty most of the day, I am very thankful that the engine room is some distance from the boiler room. It seems to me, while the states are passing other laws to protect life and property, it would be well to condemn the old lever safety valve, and require a good reliable spring-loaded pop valve having means to lock it after being set.

From my experience, as well as from articles published in POWER, it appears that ignorant firemen continue to hang heavy weights, etc., on the lever which prevent the valve from working. In a little plant a few years ago where the boilers were fitted with lever safety valves the working pressure was 100 lb., but the steam gage in the engine room registered 130 lb. and so did those on the boilers. After questioning the fireman I climbed on top of the boiler and found a piece of 2x4-in. joist placed between the lever and the roof truss.

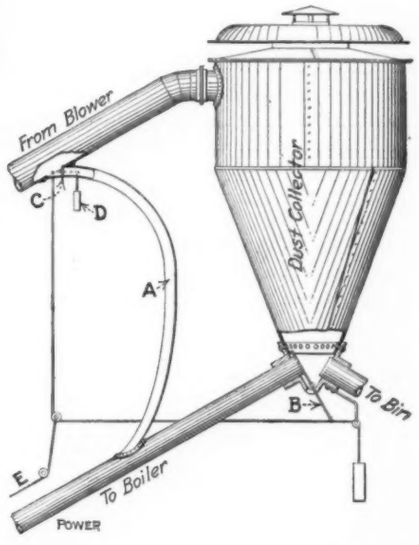
Of course, the fireman denied placing it there. If a reliable pop valve was used this could not happen.

D. E. ADEN.

Wilburton, Okla.

Bypassing the Draft in a Blower System

The illustration shows how I produced draft in a pipe carrying sawdust from a dust collector to a boiler, to move the sawdust when the incline of the pipe was insufficient for it to flow by gravity.



BYPASS AND DAMPERS ON BLOWER PIPE

By tapping the blow pipe, which is 12 in. in diameter, and connecting a 3-in. pipe *A* the outlet of which blows down the 8-in. pipe leading to the boiler, enough draft was produced to blow the sawdust

to the boiler. The gate *B* turns sawdust to the bin or boiler; gate *C* turns on the draft. When the rope is pulled in the boiler room, gate *C* having the light weight *D* attached, opens first, starting the draft. By continuing to pull the rope, gate *B* turns the sawdust under the boiler. By loosening the rope in the boiler room, gate *B* closes first, turning the sawdust into the bin, then the gate *C* closes, cutting off the draft.

CHARLES G. BUDER.

St. Louis, Mo.

Home Made Devices for the Plant

The following are three of the most useful devices about the plant that I know of; they are all home-made, too, The pipe-bending plate, Fig. 1, can be made of a piece of 4x¾-in. angle iron *A* and two sheaves *B*, and is held in a

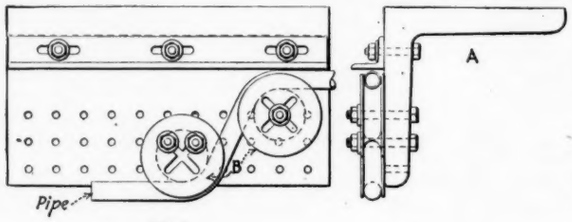


FIG. 1

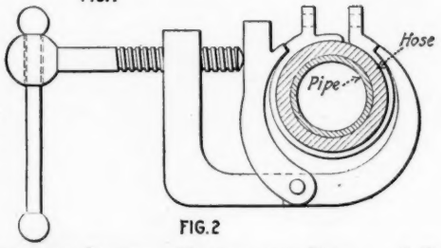


FIG. 2

FIG. 3

FIG. 1. PIPE-BENDING DEVICE HOSE-CLAMP VISE A SERVICEABLE HOSE CLAMP

vise while making the bends. The sheaves should have the radius at which it is desired to bend the pipes, but almost any bend or combination of bends can be secured by shifting the position of the sheaves, and they will be smooth and free from kinks and will be uniform. The bender will be found especially useful on brass pipes and conduit.

The hose-clamp vise, Fig. 2, makes the putting on of clamps easy. The clamp is slipped on the hose, the vise clamped on it and screwed tight, and the bolt is put in. The vise will be found especially useful on heavy hose used about the boiler room.

The steam hose clamp, Fig. 3, is made of ⅛-in. plate steel cut and bent to suit the hose and pipe for which it is intended. It is the only clamp I have ever found which will positively hold a steam hose working under high pressure. It eliminates all possibility of the firemen getting burned while blowing soot from the tubes.

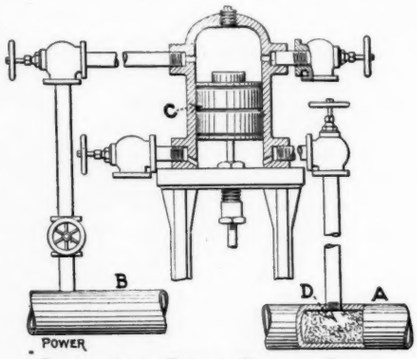
S. H. FARNSWORTH.

Chicago, Ill.

Steam Pipe Peculiarly Obstructed

We had considerable trouble with the 2-in. steam line to our feed pumps. One point of this line kept clogging, at times to such extent as to almost cut off the steam supply to the pumps. At first we were puzzled as to the cause of the trouble, but when it was repeated again at exactly the same point (the pipe being perfectly clean at all others) I concluded that the sediment could not have been carried over with the steam.

These pumps are equipped with piston governors which are connected to the steam and discharge pipes *A* and *B*, as shown. As the pressure in the discharge pipe is higher than that in the steam pipe, and the governor piston *C* leaks more or less, water moves continuously toward the latter pipe, and whatever sediment is in the water moves with it. This sediment remains in solution up to the point where the governor pipe enters the steam line, where it comes in contact with the steam, settles on the walls of the pipe, bakes, and remains as at *D*, until it is chipped out.



OBSTRUCTED STEAM PIPE TO PUMP GOVERNOR

Until provisions were made to remedy this, the pipe had to be removed and cleaned at least once a month.

K. W. KARLSON.

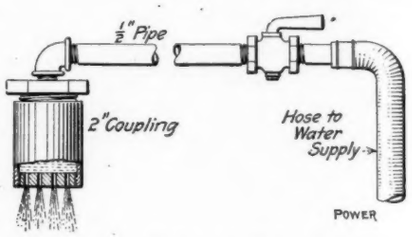
Racine, Wis.

A Handy Home Made Water Sprinkler

In many manufacturing plants, the engine and boiler rooms are the pride of the establishment and every effort is made to keep them thoroughly clean.

One of the most useful articles in our boiler house for this work is a water sprayer for dampening ashes at fire-cleaning time. Those using stationary grates and pulling ashes out through the fire-doors know how the clouds of fine ashes arise and settle on the boiler fronts, and all surrounding walls and objects.

The sprayer is made of pipe fittings, as illustrated. When cleaning a fire, after pushing it back to the bridge-wall, the clinkers are allowed to burn off if possible, then with the damper open, the ashes are sprayed, taking care to keep the water off the hot brickwork and dead-plate. The grates are not harmed as they are fairly cool and the water warmed before reaching them.



SPRINKLER MADE OF PIPE FITTINGS

A heavy and serviceable sprayer head may be made by screwing a plug into a 2-in. coupling and cutting it off flush with the end of coupling. Then the plug is drilled full of $^{3}/_{32}$-in. holes. In the other end of the coupling bushings are used to reduce to the size of the water-supply pipe. A length of ½-in. pipe about 2 ft. longer than the firebox is connected to the water supply with a short length of flexible hose.

This arrangement is also handy for sprinkling floors or anything the moving of which creates dust.

I. S. CHAMBERLAIN.

Paterson, N. J.

Repairs to a Gridiron Valve Gear

Fig. 1 shows the cylinder and valves of an automatic engine I was employed to adjust so that it would require less steam and give better speed regulation. The steam valves are long and narrow and admit steam very rapidly, as they are of the gridiron or multi-port type. When raised they admit steam, and falling they cut it off.

The exhaust valves are of the same general type, but are larger and move horizontally at right angles to the axis of the cylinder. They are operated by the valve-gear, shown in Fig. 2, in which

A is a gage plate that moves parallel to the axis of the cylinder. It is driven by an eccentric on the crankshaft. The secondary links are pivoted at *B* and *C* so that, when the gage plate moves, as indicated by the arrow, the upper valve stem *D* is pushed inward to close the crank-end valve, and the lower stem *E* is drawn outward to open the head-end valve.

In practice the throttle valve could not be opened wide as it would cause the engine to race until there was danger of rupturing the flywheel, and causing other damage. The reason for this action was not plain as all four valves worked freely by hand, and opened and closed promptly when steam was admitted to the cylinder.

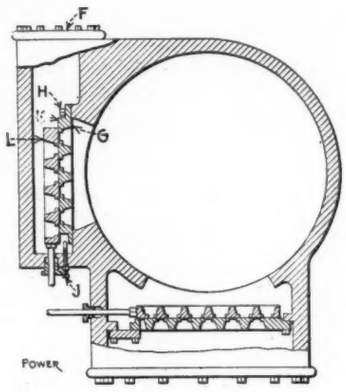


FIG. 1
SECTIONAL VIEW OF GRIDIRON VALVE

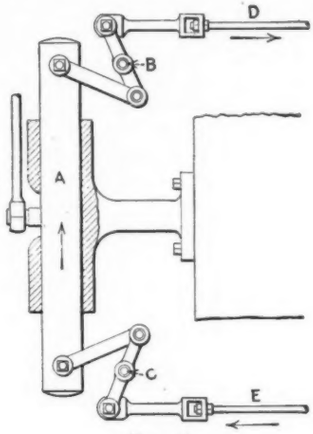


FIG. 2
GRIDIRON VALVE-GEAR

Indicator diagrams showed that the cutoff took place early in the stroke, but steam was admitted after the cutoff valve closed, and this was sufficient to give dangerous speed.

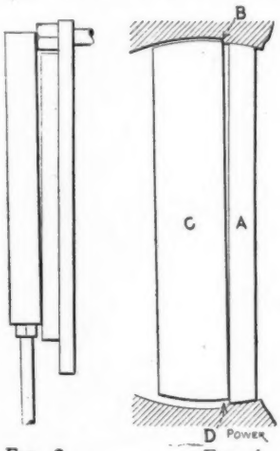


FIG. 3 FIG. 4
IMPERFECTLY SEATED VALVE

To understand the cause for this condition it will be necessary to study the design of the steam valves and their seats. When the round steam-chest cover *F*, Fig. 1, was removed, it was found that the valve seat *G* was held in place by the capscrew *H*, and the lower end was fastened by another screw *J*, Fig. 1. The shoulder *K* in Fig. 1 lets the capscrew heads down low enough to clear the valve *L* when moved to its highest position, or at least this was the case before repairs were completed. As the screw *H* was damaged when removing it to take out the valve seat, a new one was substituted, but the head was longer than the old one. With the valve in its lower position this was not noticed, but when lifted by the valve-gear, it took the position shown in Fig. 3; hence it leaked badly.

The capscrew was put in a lathe chuck and shortened about ⅛ in., after which there was no trouble from this source, but still the engine raced dangerously. The valve seat *A*, Fig. 4, was taken out and planed off; consequently it was not so thick as before, leaving a shoulder *B* on which the valve *C* would ride as shown; therefore steam leaked through the tapering opening. The opposite edge showed the same defect, at *D*; hence the valve was raised by one or the other shoulders at almost every stroke, admitting enough steam to cause racing unless the throttle valve was nearly closed. To remedy this well concealed, but dangerous defect, I removed the seat *A* and the valve *C* and filed off the shoulders with a half-round file.

This valve was on the head end; the crank-end valve seat had to be given the same treatment. After this was finished the engine maintained a uniform speed with the throttle valve wide open.

W. H. WAKEMAN.

New Haven, Conn.

Criticize These Diagram

The accompanying diagrams were taken from an 8½x6-in. vertical piston-valve (inside-admission type), shaft-governor engine, making 400 r.p.m. under 80 lb. steam pressure. With this type of valve the eccentric is set behind the crank instead of ahead of it. The eccentric is loose on the shaft and is screwed tight to a movable lug in the shaft, the lug being held down by a tension spring against the action of the governor weights.

This engine takes steam from a 2-in. pipe which branches from a main supplying steam to other larger engines. The 2-in. pipe has a reducing valve which reduces the pressure from 120 to 80 lb.

Will readers comment on these diagrams?

VICTOR BONN.

Brooklyn, N. Y.

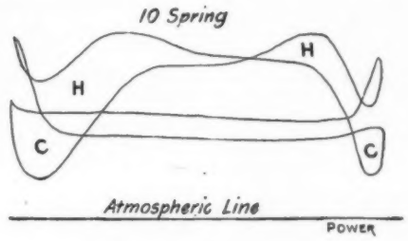


FIG. 1

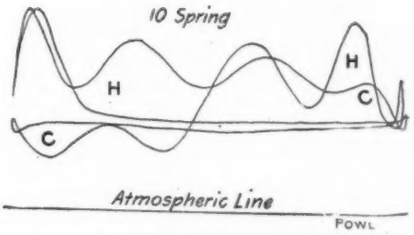


FIG. 2

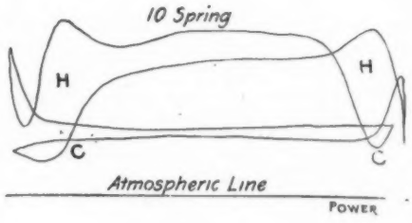


FIG. 3

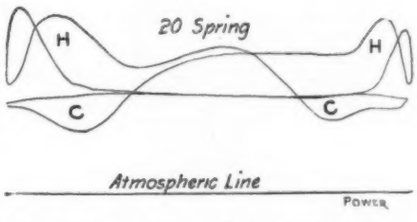


FIG. 4. HIGH-SPEED ENGINE DIAGRAMS

Commenting on the "sootability" of Pittsburgh, *Graphite* says that 40 per cent. of the dust in that city is soot, and that its citizens wear plain black soots, with stripes when it rains. While Pittsburgh is apparently one of those few places where everybody gets sooted, nevertheless a pound of prevention is well worth two pounds of soot.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Correctives for Fluctuating Water Level

In the June 25 issue, B. H. Chester asks the cause of the fluctuating water level in a Babcock & Wilcox boiler.

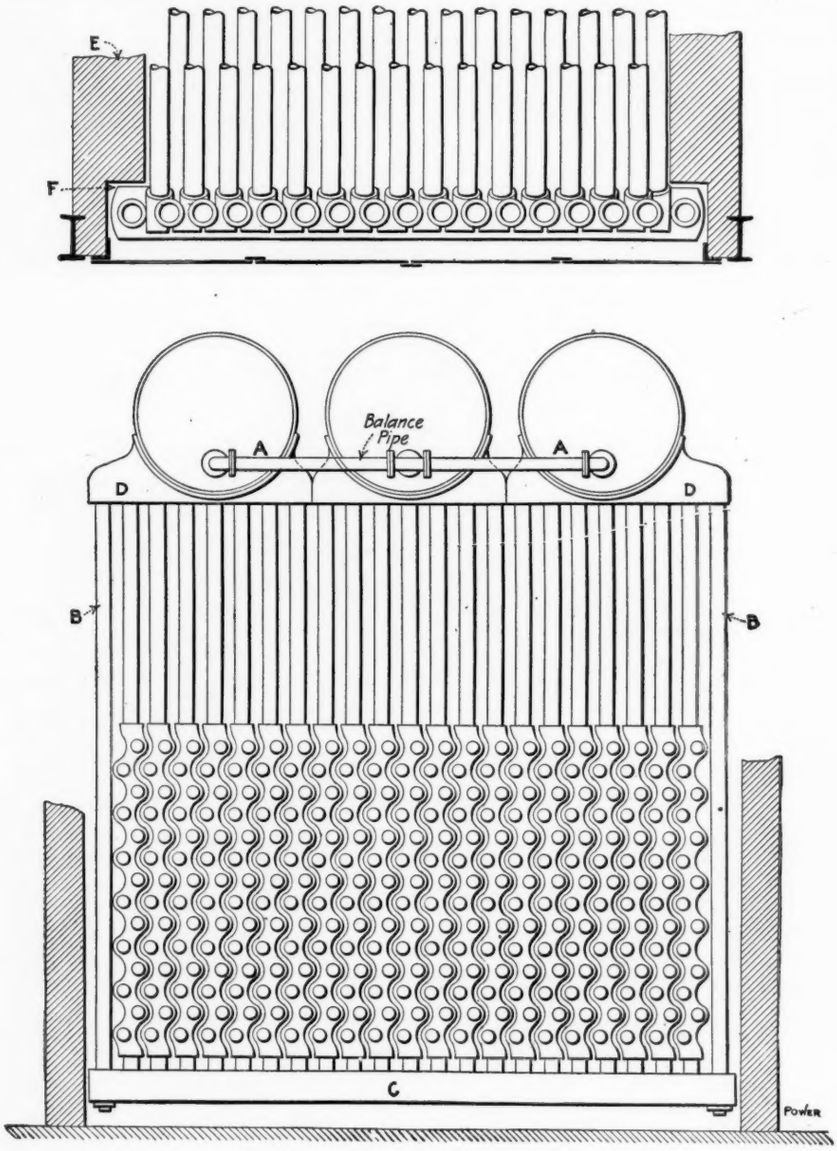


FIG. 1. REAR ELEVATION AND PARTIAL TOP PLAN OF WATER-TUBE BOILER, SHOWING BALANCE PIPES TO AID CIRCULATION

This trouble would be extreme if the mud drum of the boiler was stopped up with mud or sediment. If it is possible for him to attach a water column or gage-glass to both the front and rear heads of each drum, he would perhaps find a greater variation than he thought existed. The illustrations show improvements invented and patented by me to overcome this trouble, which is due to the drums supplying a proportionately larger amount of water to the upper rows than to the lower rows of tube. This causes steam pockets to form in the lower tubes which impede the circulation.

The rear end of the boiler is shown in Fig. 1. The horizontal balance pipe *A* aids in maintaining a uniform water level in the drums. This pipe should be connected high enough to avoid interference with the downward current in the cross-boxes. The vertical or balance pipes *B* connect the mud drum *C* directly to the cross-boxes *D*.

The brick setting or iron casing *E*, Fig. 1, has inner perpendicular pockets *F* into the lower ends of which are projected the ends of the mud drum. This protects the pipes from the heat of the gases and thereby prevents steam pockets

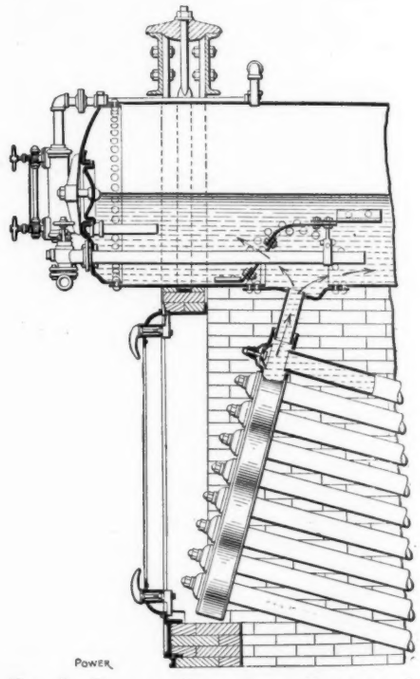


FIG. 2. PARTIAL SECTION OF BABCOCK & WILCOX BOILER

forming within them. This means a free circulation of water and a uniform water level because the lower tubes receive their supply simultaneously with the feeding of water to the upper tubes.

DANIEL WEBSTER.

Brooklyn, N. Y.

B. H. Chester's trouble may be due to more than one cause. To begin with, he may have recently been running horizontal return-tubular boilers, which are noted for their steady water level, and he must not expect any water-tube boiler to carry an equally steady water level. I do not think he has anything to worry about.

I have known of a B. & W. boiler, while being forced, to show 2½ gages of water, and in less than 2 min., during which time the fires were banked, the water could be seen to creep down out of sight in the glass. This is due to the large amount of heat absorbed by the water while the fires were forced, and this shows that the condition of the fire has much to do with the water level. Again, the condition of the water will cause the level to be unsteady in any boiler. If the boiler is dirty and has not been washed out frequently, it will prime.

The baffle-plate shown in the partial vertical section, Fig. 2, is supposed to direct the ebullition toward the back end and the space around the plate should be sufficient to let water pass to the water column through the short pipe and be comparatively quiet, but in some cases I believe the space for the water to pass is too great, hence the fluctuating level. It may be that the baffle-plate has been dislodged. I would advise him to first wash out the boiler, and, if this does not improve matters, I would inquire as to the advisability of decreasing the space through the baffle-plate so that the water, as it boils up by the plate will not rush by it to the water column too fast.

A. C. WALDRON.

Revere, Mass.

Mr. Haight's Engine Trouble

A. I. Haight's engine trouble, mentioned in the May 7 issue, reminds me of two similar cases of broken pistons. One was on a simple 20x36-in. Corliss engine running at 103 r.p.m. with 150 lb. steam pressure. The piston was of the built-up type in which the follower plate was held in place by six 1⅛-in. tap bolts. On several occasions the heads of these bolts broke at the end of the thread, and on two occasions, the head and short section of bolt went through the exhaust valve without doing any damage. At another time the bolt head was pushed through the cylinder head without doing further damage. The last time this happened the bolt head caught between the cylinder head and piston, breaking the cylinder head, piston, piston rod, and crosshead shoe and twisting both exhaust-valve stems. A new cylinder head, piston, piston rod and crosshead were ordered and new valve stems made. The new piston was of the same type, but stud-bolts were used instead of tap-bolts.

The follower plate was counterbored on the back to slip over the collar on the studs, and the weakest point in the stud is just back of the collar, so that in case of breakage, the bolt and nut cannot get out and do harm. The reason the old bolt broke was that the piston was sprung out of true. Two different follower plates broke and were replaced with new ones, but as the engine was much needed it was kept in operation.

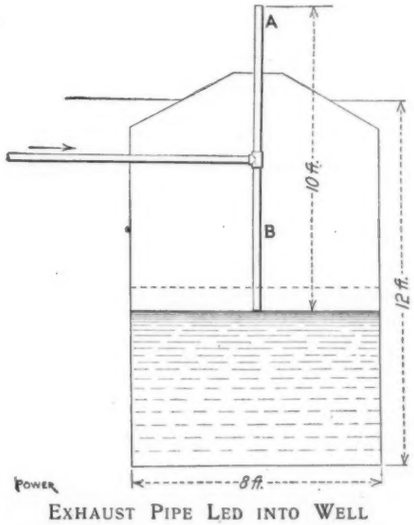
In the other case the cylinder was 32x48 in., having a piston valve and running at 85 r.p.m. The trouble was thought to be due to a piece of a broken snap ring being caught in the counterbore so that it broke out a piece of the follower plate which dropped between the cylinder head and piston, and at the next revolution the nut on the end of the 5½-in. rod pushed the head out, taking part of the cylinder with it and springing the rod. A new valve, piston, valve chamber and cylinder were required, as the valve chamber and cylinder was cast in one piece. In the first case the load on the generator stopped the engine before the throttle was closed, and in the second case the engineer closed the emergency throttle valve as the piston was making the stroke that pushed the head out. A remarkable thing about this accident was that there was a craneman asleep on the floor about 10 ft. directly back of the cylinder and, although he was badly scared, none of the pieces came within 6 ft. of him.

J. C. HAWKINS.

Hyattsville, Md.

Why This Peculiar Exhaust?

A. O. Fisher's inquiry under this heading in the June 25 issue is easy to answer. When the water in the well is



EXHAUST PIPE LED INTO WELL

lower than the end of the pipe *B*, the steam and water rise to point *A*, because nothing prevents the flow of steam to the atmosphere; hence, with the steam, a certain amount of water is lifted.

When the water in the well is above the end of pipe *B*, if the steam escaped at point *A*, it would form a vacuum in pipe *B*, as the end of pipe *B* is sealed by the water in the well. The water in the exhaust naturally takes the line of least resistance and falls through *B* into the well and, in falling, establishes an air current in *A* in the direction of *B*, and therefore carries the steam with it.

If the action of the steam and water coming out at *A* becomes a nuisance or disadvantage to Mr. Fisher, it can be stopped by extending pipe *B* further into the well, so that it will always have a water seal at its base.

C. H. PARSON.

New York City.

A. O. Fisher mentions that when the bottom of a pipe into which the exhaust pipe of his engine is connected, is covered with water, no steam is exhausted to the atmosphere, but, when the water falls low enough to uncover the bottom of this pipe, exhaust to the atmosphere does occur.

In times of high water the well acts as a jet condenser and the cool water in it condenses the steam in the lower leg of the pipe, thereby causing enough vacuum to draw all the steam down to the water so that none escapes from the top of the pipe.

G. H. MCKELWAY.

Brooklyn, N. Y.

Is the Packing Defective?

Replying to James Pierpont's inquiry under this heading in the July 2 issue, I would say that my experience with the style of metallic packing he describes extends over several years and I have found only one effective way of preventing it from leaking. After ascertaining that the steam is not leaking around the packing case (which can only be remedied by a renewal of the composition metallic ring between the cylinder end of the stuffing-box and packing case) remove and thoroughly clean the packing with gasoline, polishing the wearing surfaces to remove any dirt or scale lodged there.

When reassembled, give the piston rod a coating of a mixture of cylinder oil and graphite before replacing it in the stuffing-box. Unless the piston is scored or badly worn this should remedy the trouble. I always have an oil cup connected above piston rods using metallic packing and use cylinder oil as a lubricant and have experienced but little trouble.

L. A. LESHER.

Mandeville, Ark.

If the piston rod of Mr. Pierpont's engine is badly worn or fluted, the only remedies are to have it turned down or, better still, have a new one made. If it is in fairly good condition see that sufficient clearance is between the different sections to allow the spring to hold them against the rod without binding at the ends. Cut a piece of valve-stem packing, not larger than ⅜ in. and long enough to fit nicely in the stuffing-box; cut the ends square and butt them together. Put one such ring in the bottom of the box and another next to the

gland. This will prevent steam from leaking by the packing case. Draw up the gland as tightly as possible and it should be steam-tight.

H. C. MACAULAY.

Rumford, Maine.

Mr. Pierpont's trouble is undoubtedly due to weakness of the springs that hold the metallic rings against the piston rod. Perhaps the rings are worn excessively; if so, new rings and springs should be used.

If the springs are at fault they may be given more tension by pulling the coils further apart. I would suggest that Mr. Pierpont remove and clean the packing and the stuffing-box. This would possibly correct the trouble.

R. G. COX.

Harrisburg, Penn.

I have had some experience with the packing which Mr. Pierpont mentions and have always found it very satisfactory. If the rod is worn flat, the only way to get a tight job is to turn down the rod, taking off enough to make it round. If the rod is round, perhaps the rings do not fit it tight enough, in which case the rings should be removed and the springs shortened. In reassembling care should be taken to break the joints of the two rings in each case.

With this kind of packing a lead ring is placed in the bottom of the stuffing-box to prevent steam leaking out around the case. This ring is made from ⅛-in. lead pipe. Some engineers lap the ends but I have had better success by reaming out one end of the ring and shaving the other end to fit it. The ring should be made as large as the stuffing-box as it makes a better joint. In Mr. Pierpont's case it may be necessary to place a lead gasket between each of the cases, as steam leaking by the bottom set of rings will find a way of escape between the cases.

C. B. HUDSON.

Lowell, Mass.

Cleanliness and Mechanical Efficiency

From C. E. Aldrich's letter under this heading in the June 11 issue, I infer that he is not wholly in favor of cleanliness in the plant. If he means cleanliness obtained at the sacrifice of efficiency, I agree with him. This thing in its relation to the plant is the same as its relation to the body. Most of us can do just as much work with a dirty face and overalls as we could with clean ones. In some plants this is done, but they are not pleasant ones to visit.

A person feels better when clean and a clean machine has the same effect on him. To clean regularly means that when repairs are necessary it does not require half a day's digging to find the thing to be repaired. No sane man would let a generator or motor be dirty. Why should he do it with anything else? A man with ambition and pride enough to keep an apparatus clean and polished on the outside will not neglect the inside, as Mr. Aldrich intimates.

The man who is ready with excuses for a dirty or pounding engine, leaky or plugged lubricators, choked ash and soot pits, etc., is spontaneous with excuses for anything else that is wrong. We all might take a lesson from the way such work is done on ship-board. If the management is reluctant to buy cleaning supplies it is unfortunate, but once it sees a dirty plant made clean it is encouraged to do so.

A. P. HYDE.

Binghamton, N. Y.

C. E. Aldrich is right in his conclusions about mechanical efficiency being more desirable in an apparatus than outside polish. But I see no reason to criticize that Western concern for offering a prize for the best looking apparatus, "outside and in," since that indicated that it is giving proper consideration to both and educating its men to obtain, not only an efficient plant, but a clean one as well.

I do not think Mr. Aldrich intended a criticism, but his letter leads one to consider it as such.

LLOYD V. BEETS.

Nashville, Tenn.

Modern Pumping Plant

In the issue of May 7, Kirby Thomas presents a highly entertaining photograph of a pump run by a "Missouri hay burner" and with gears that should set the *American Machinist's* teeth on edge. But seriously, while the efficiency may be only 15 or 20 per cent., even when we neglect the thermal efficiency of the prime mover, that pump is all right. While I feel a trifle hurt, since I used to see as crude devices as this when I was a native son of California before the state became a chicken fence of electric lines, my personal feelings are not the point. There is often a tendency to over-refinement on the part of engineers, only held in check by the unprogressive ideas of the "old man," and this extreme case may serve to illustrate "Tightwad's" side of it.

Speaking of the general case where this type of water elevator is used, rather than any special case, it is to be doubted whether, even Mr. Thomas, if called upon by the *ranchero* to act as consulting engineer, and with all the data before him, would prescribe any other method. This one-mule power should be sufficient to raise about 50 gal. of water per minute to a height of 15 ft. with our mechanical efficiency of 20 per cent. If the mule were city fed it might be profitable to replace him, but a Mexican mule depends about as much on fancy foods, as his Vicksburg driver, who lives near the coal yards, depends upon city gas or electricity for cooking. "Fuel" for the mule is more or less cheap, costing almost nothing on some ranches; hence a mule is a good sort of furnace and boiler to use.

Where these installations are common, it happens that the service is decidedly intermittent, water being required for occasional irrigation of the small garden patches between an *arroyo* bed and the high ground—often but an acre or two in one place, or within range of one pump. If the "engine" was not busy at this, it would be hobbled and wandering off on three legs toward the foothills in search of a change in diet.

Why then own the mule at all? Because once in a while he is wanted for a trip to town, and it often happens that several are wanted. So the investment has to be made anyway and if he is fed anything at all it takes about as much to keep him "under steam" while loafing as while working. Even if he had to be bought for this purpose only, his price plus several generations of him would be less than a small electrical equipment, including transmission lines and an "infant" centrifugal pump.

E. G. MEDART.

Quincy, Ill.

Electrolysis Pipe Corrosion Doubted

Mr. Phelps' suggestion, in the June 25 issue, that the destruction of the pipe was caused by electrolysis, gives very meager information, but it would seem to be unlikely, for he mentions that the place where the trouble occurred was not near either street railway tracks or pipes that might lead to those tracks.

If the eating away of the pipe had been caused by electrolysis from stray electric railway currents, the current would have to have a way to reach the pipe from the tracks and a way to return to them or to the power house through pipes, water, or some other conductor.

If the gas pipe runs near the tracks at some place, even though distant from the point where the trouble is, electrolysis might reasonably be thought the cause if some fairly good conducting path led from the damaged pipe to the power house, but in the absence of this the theory would seem to be untenable and the cause should be looked for elsewhere, although where it would be hard to say.

G. H. MCKELWAY.

Brooklyn, N. Y.

An oil-burning furnace equipment for its new shops will be installed by the Portland (Ore.) Ry., Light & Power Co.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Milky Appearance of Deep Well Water

Is the milky appearance of water when first drawn from a deep pipe well any indication of presence of impurities which may render the water unfit for use as a boiler-feed water? What is the cause of the appearance and how may its nature be determined?

T. W.

The appearance of the water when first drawn, is probably due to liberation of gas from the water, generally the liberation of carbonic acid in the form of minute bubbles which impart a whitish appearance to the water, and are mostly redissolved as the water clarifies. As few well waters are free of lime, the presence of carbonic acid tends to make a harder boiler scale.

The best test for presence of carbonic acid is to take a sample of the well water after it has clarified, and add an equal quantity of clear lime water. If carbonic acid is present a milky precipitate of carbonate of lime will be formed.

Blowing Off Boiler under Pressure

Why is it objectionable to blow off a boiler when under pressure?

H. C.

Because the less the time employed in relieving the joints of stress the greater the danger of disturbing the joints and causing them to leak.

To Find Pitch of Rivets

How can the pitch of the rivets be determined for a double-riveted butt and double-strap joint which is to have ⅞-in. rivets and a strength of plate between the rivet holes on the outer row which will be 82 per cent. of the strength of the solid plate?

W. S. F.

Let

P = Pitch;
t = Thickness of plate;
TS = Tensile strength of plate;
d = Diameter of rivets.

Then

$P \times t \times TS$ = *strength of solid plate*

and

$(P - d) \times t \times TS$ = *strength of plate* between the rivet holes on the outer row.

The conditions require

$$\frac{(P-d)\,t \times TS}{P \times t \times TS} = 0.82 \qquad (1)$$

By canceling out t and TS from numerator and denominator of the first member of (1) we obtain,

$$\frac{P}{P} - \frac{d}{P} = 0.82 \qquad (2)$$

and as $d = 0.875$, the equation becomes

$$\frac{P}{P} - \frac{0.875}{P} = 0.82 \qquad (3)$$

from which it is found that

$$P = \frac{0.875}{0.18} = 4.86 + \qquad (4)$$

or practically 4⅞ in.

Openhearth Steel

What is meant by basic and acid methods of manufacturing openhearth steel for boiler plates?

B. A.

The process is basic or acid, depending on the kind of furnace lining employed. The basic process is a dephosphorizing and desulphurizing one, and is the one most commonly employed, as it can use pig iron that is high in phosphorus; while the acid process is one in which the furnace lining is acid or silicious, and therefore not well adapted to remove phosphorus.

The growing popularity of the basic openhearth process is due to the exhaustion of low phosphorus ore.

Power Required for Ice Machine

How much horsepower is required to drive a 100-ton ice machine?

A. H. A.

One hundred and twenty to one hundred and thirty, according to the efficiency of the plant.

Merits of Scotch Boiler

How does the Scotch marine boiler compare with the horizontal return-tubular boiler as a stationary boiler where space is very limited?

T. R.

The Scotch marine boiler has the advantage of being free from infiltration of air through a brick setting, but shares the disadvantage of most internally-fired boilers, viz.; that little time and space are given to the gases to burn completely before coming into contact with the cool surfaces surrounding the furnace. It has the advantage of compactness, and for short runs, has the further advantage that there is no mass of brickwork to be alternately heated up and cooled off.

Cause of Engine Belt Running to Side of Pulley

What will cause the main belt of an engine to run to one side of the pulley when the receiving jackshaft is parallel with the engine shaft and both pulleys are evenly crowned?

J. N.

When iron pulleys are faced, the cut of the turning tool is usually made in one direction clear across the face and the shallow screw thread made by the turning tool has some tendency to urge the belt to one side of the pulley. But when iron pulleys are finished with an ordinary smooth cut of the turning tool, the ridges soon become worn down so smooth as to produce no side creeping of the belt, and if the belt continues to run to one side it is due to the fact that one side of the belt is tighter than the other, the tighter side running to the crown of the pulleys.

Screening Air Supply

What is the best way to prevent floating dust and grit from being carried with the air supply into an air compressor?

C. G. C.

By taking the air supply through a good sized duct which is divided across by a number of cheese-cloth screens.

High Duty Attachment for Pumps

Why is it impossible to use steam expansively in a direct-acting pump unless it is fitted with a high-duty attachment?

M. T. D.

In a direct-acting pump the resistance overcome by the piston is nearly the same at every part of the stroke. When steam is used expansively its pressure decreases during expansion, and a high-duty attachment is necessary for storing up as much energy before cutoff takes place as may be necessary, during expansion, to be expended as useful energy, in addition to the energy which is developed by expansion.

Study Questions

This Week's Questions
Last Week's Answers

71) Steam is turned into and condensed in a barrel of water until the weight of water is increased from 360 to 379.1 lb. and its temperature raised from 52.8 to 109.6 deg. F. The steam pressure is 79.8 lb. gage. What percentage of moisture did the steam contain?

(72) What is the indicated horsepower of a 28 and 52 and 72 by 54-in. triple-expansion engine running at 100 r.p.m., when the mean effective pressures are, in the high-pressure cylinder, 60 lb., intermediate 38 lb. and low 18 lb.?

(73) To withstand a shearing strain of 20,000 lb., how many ⅞-in. rivets will have to be used, if their ultimate shearing strength is 40,000 lb. per sq.in. and a factor of safety of 4½ is to be allowed?

(74) Assume a body weighing 2½ short tons moving without friction or air resistance. It has just covered 315 yd. in 179 sec. with no force acting upon it. For a period of ⅔ min., what force would have to act so that thereafter the body would cover 10,800 in. in $^1/_{30}$ hr.?

(75) To change the air in a room, 40x80 ft. by 12 ft. high, five times an hour, what quantity of air per minute would a ventilating fan have to discharge?

Answers to the above will appear in the next issue. Answers to last week's questions follow:

(66) Let

x = First engine's rated hp.;
y = Second engine's rated hp.

Then

$0.80x$ = Hp. first engine actually develops;

$1.20y$ = Hp. second engine actually develops;

and

$$x + y - 10 = 0.80x + 1.20y \quad (1)$$

but

$$0.80x = 1.20y$$

Therefore

$$x = \frac{1.20y}{0.80} = \frac{3y}{2} \quad (2)$$

Substituting in (1)

$$\frac{3y}{2} + y - 10 = 1.20y + 1.20y$$
$$3y + 2y - 20 = 2.4y + 2.4y$$
$$5y - 4.8y = 20$$
$$0.2y = 20$$
$$y = 100 \ hp.$$
$$x = \frac{3y}{2} = \frac{300}{2} = 150 \ hp.$$
$$0.80x = 120$$
$$1.20y = 120$$

The rated capacities are therefore 150 and 100 hp., respectively, and the power actually developed by each, 120 hp.

(67) The ratio of the voltages is as the number of turns, therefore,

$$110 : 2000 : : 100 : x$$
$$x = \frac{2000 \times 100}{110} = 1818 \ turns$$

(68) Let x = original amount.

After giving 1 lb. to an oiler there is left $x - 1$. Half of this goes to the boiler room, leaving $\frac{x-1}{2}$. Another pound is given an oiler, leaving $\frac{x-1}{2} - 1$ at the end of the first day. Call this quantity a.

Then, as the same thing is done each day, there will remain at the end of the second day

$$\frac{a-1}{2} - 1$$

Call this quantity b.

Then at the end of the third day there remains

$$\frac{b-1}{2} - 1$$

Call this c.

At the end of the fourth day there remains 1 lb.; hence

$$\frac{c-1}{2} - 1 = 1 \ or \ c = 5$$

Then

$$\frac{b-1}{2} - 1 = 5 \ or \ b = 13$$

and

$$\frac{a-1}{2} - 1 = 13 \ or \ a = 29$$

and

$$\frac{x-1}{2} - 1 = 29 \ or \ x = 61$$

The problem may be worked backward arithmetically, adding on each time what had been given out, starting with the 1 lb. left, as follows:

1 + 1 = 2 2 + 2 = 4 4 + 1 = 5	Fourth day
5 + 1 = 6 6 + 6 = 12 12 + 1 = 13	Third day
13 + 1 = 14 14 + 14 = 28 28 + 1 = 29	Second day
29 + 1 = 30 30 + 30 = 60 60 + 1 = 61	First day

(69) The formula for the efficiency of a hydraulic ram is

$$n = \frac{q h'}{(Q - q) h}$$

where

q = Quantity of water pumped;
h' = Height to which it is raised;
Q = Quantity of water supplied;
h = Head of the supply.

The problem gave n = 60 per cent.; h' = 60 ft.; Q = 100 cu.ft. per sec.; h = 10 ft.

Substituting

$$0.60 = \frac{q \times 60}{(100 - q) \times 10}$$

Simplifying

$$60q = (100 - q)\ 6$$
$$60q = 600 - 6q$$
$$66q = 600$$
$$q = 9.09 \ cu.ft. \ per \ sec.$$

As 1 cu.ft. = 7.48 gal., the gallons per minute discharged is

$$9.09 \times 60 \times 7.48 = 79.59 \ gal.$$

(70) The pressure corresponding to 1 in. of water is 0.0361 lb. per sq.in. Then 20 in. of water is

$$0.0361 \times 20 = 0.722 \ lb. \ per \ sq.in. \ gage$$

For absolute pressure the atmospheric pressure must be added. As 1 in. of mercury corresponds to 0.491 lb. per sq.in., the atmospheric pressure at 29 in. of mercury is

$$0.491 \times 29 = 14.239 \ lb. \ per \ sq.in.$$

Then the absolute pressure required is

$$0.722 + 14.239 = 14.961 \ lb. \ per \ sq.in.$$

Power Gas from Coal Seams

The theoretically interesting scheme for producing gas directly in the coal deposits and utilizing it on the surface, is to be tried in both England and the United States, according to the statement by Sir William Ramsay before the recent meeting of the Institution of Mining Engineers, in furtherance of the proposition which he first brought forward about three months ago.

The scheme, according to *Mechanical World*, involves driving bore holes down to the coal seams; lighting the coal and conveying to it water and air to produce a combustible gas which is to be brought to the surface by bore-pipes, and then used in gas engines to supply power for industrial and other purposes. As the gas temperature would be very high, the oil would distill in the pipes and be separated from the gas in some way, and would also be conveyed to the surface for use.

If gas can be thus produced, its escape through cracks and fissures cannot be prevented, and the subterranean combustion of coal would lead to serious subsidences and collapses. Also, a fixed composition of the gas cannot be relied on. The incursion of water, which has already to be dealt with in ordinary coal-mining work, would also play a part in connection with the underground fire. When these and other difficulties are provided for, the scheme may safely be tried.

The author of the proposition states that the system is to be tried, hence coal-mining and financial interests are evidently prepared to incur the necessary expenditure.

Confessions of an Engineer

By R. O. Warren

Due to excessive friction in shafting bearings, needless power is expended.

Engineer Warren advises Wood to buy an engineer's level, the use of which astonishes the manager.

If one thing more than another irritates, it is interference, and I was sometimes nettled with Wood's attention to my power plant. It is true that he had caught me napping and neglecting opportunities more than once, but that did not cause me to look upon his interference with any additional favor, and I made up my mind that if the chance ever came I would jump on him with both feet. The opportunity came sooner than I anticipated.

Increased Load on Engine

I had noticed for some time that the main engine was cutting off later in the stroke than it had for months before, but I made no attempt to ascertain the cause of the additional load. The coal report also showed an increase in fuel consumption over what had been used when we first began keeping plant records.

One day when Wood came into the engine room I casually inquired if business had picked up and how many new machines had been put in operation. Wood replied that business had been a little slack for the past year and that no new machines had been added to the equipment.

The matter was dropped and I began to look about for the cause of increased power consumption. My power-plant apparatus was carefully gone over until I knew that the trouble was not there. The boilers were free of scale; therefore the increased fuel consumption could not be due to dirty boilers. It was "dollars to doughnuts" that the seat of the trouble was out in the factory.

I hunted up the old mechanic in charge of the repair work about the mill and asked him, in a way that indicated but slight interest on my part, how often he lined up the shafting.

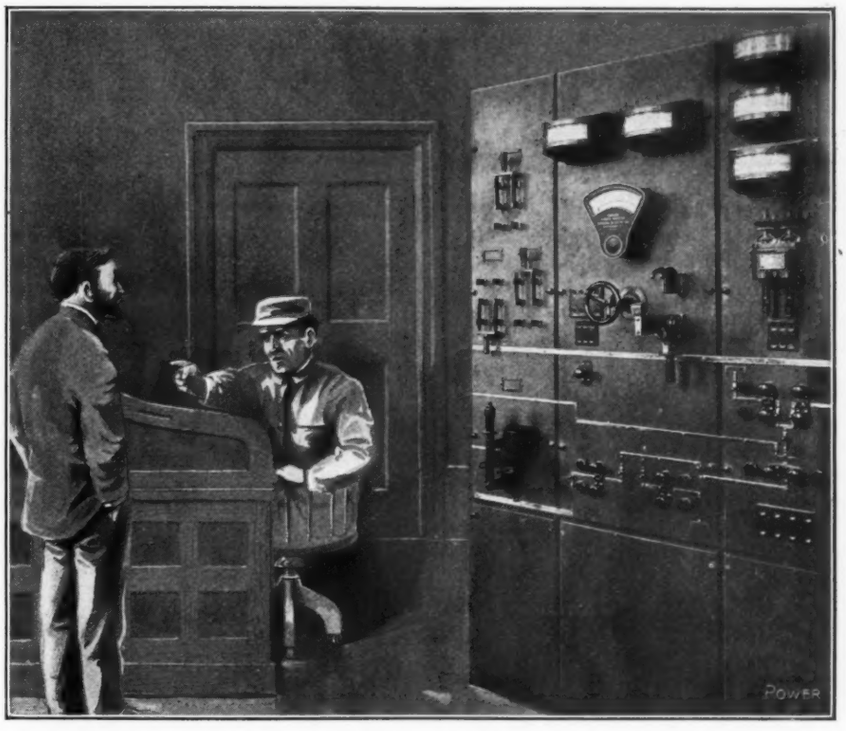
"Gosh-almighty! Them shafts h'aint been lined since the factory was built. They don't need it, for when they were put up I put them there for keeps. I never have to do my work twicet."

Found Shafting Out of Line

When I got an opportunity, unobserved, I sighted along a line of shafting and found, with the aid of the targets used, that the shaft was out of level as well as out of alignment sidewise.

Here, then, was the root of the trouble. The shafting had been allowed to take care of itself and the increased friction in the bearings was the cause of the increased power consumption. I followed my investigations further and was convinced that while Wood had been attending to power-plant matters the factory shafting had been neglected, and it made me feel good.

Further talk with the old mechanic disclosed that the old method of lining the shaft had originally been used—that is, of stretching a wire parallel with the shaft and measuring from the shaft to the wire. The old man had used a spirit-level on the shaft from hanger to hanger and, although he had doubtless been careful in doing his work, the process must have been tedious and uncertain, and considerable error had crept in between one end of the long shaft and the other. With this information I awaited the next visit from Wood.



Don't Blame Me. It's up to You, Wood. You Remove Excessive Line Friction and there Will Be no More Trouble in Keeping Up the Speed

Speed Drops

In a few days he came and wanted to know why the speed had fallen below normal that morning. Matters could not have been better suited to my purpose.

"Below normal?" I exclaimed, as if surprised.

"That is what I said," snapped Wood. "Furthermore, this is not the only time the speed has dropped during running hours."

"I guess that is true," I replied. "I have noticed that the load on the engine has been steadily increasing of late and, what is more, it is not all productive work. There is something like a 30 per cent. friction load on this engine that does not belong there, but you can't come in here and place the blame on me; it is up to you, Wood. If you will remove some of that friction there will be no trouble in keeping up the speed, because there is not enough boiler capacity to overcome ten times as much friction as there is any need of. Of course, we can put on another boiler if you don't want to get onto your job of lining the shafting."

I was enjoying myself to the full, and talked to him like a brother.

"No, no!" hurriedly ejaculated Wood at my suggestion. "There's no need of any more boilers. You say it is up to me to reduce the load. What do you expect me to do, stop manufacturing?" This with sarcasm.

Warren Gives Advice

"Hardly that," I replied. "But if I were superintendent I would take a 'slant' at the line shafting and see how much it is out of line. I have got a ten-spot that says the shafting is 1 in. out of true, and I will venture to say that it is even more."

"What makes you think so?" asked Wood, with surprise.

"I don't think it, I know it! What can you expect when a shaft in this mill hasn't been lined up since it was first installed, and then the old spirit-level and line system was used?"

"When this mill was built," replied Wood, "it was built extremely heavy and I don't believe that the shafting is out of line. I will say this, however, that I have not had the chance to look after it since I have been on the job. If there is anything in what you say, I am willing to eat crow. I will have the machinist start looking over the shafting as soon as we shut down Saturday noon."

Shaft-aligning Instrument

"Going to use a spirit-level and wire?"

"Of course, what else would I use?"

"Why don't you blow yourself to an engineer's level?"

"A what?"

"A shaft-aligning and leveling instrument. You can get a telescopic level like 'good' engineers and surveyors use, if you have the price, and that wouldn't break most men."

I said this with as much sarcasm as I could command. "But just to show you that it would be money well invested, I know of one firm that saved nearly $1000 in one year by keeping its shafting in shape. They had about 2000 ft. of it and went over it in something less than 50 hours. It would take some time to do the same job your old-fashioned way."

Wood winced, but was game and wanted to know more about the instrument.

"What does it look like; how does it work?"

Seeing he was getting interested, I explained: "The outfit consists of an architect's level and some targets. Some of these levels have a telescope that will magnify about 20 times and are good over a shaft 600 ft. long. That will cover anything we have got here.

"When you get ready to line up a shaft, put up a fixed target that is arranged for horizontal and vertical adjustment. A lantern behind this fixed target makes it an easy matter to work in dark places or at night, if necessary. A portable target can be hung from the shafting by a clamp so designed that the center of the target will remain the same distance from the center of the shaft, no matter what the diameter may be."

"Seems simple enough, but won't the cost of keeping the shafting aligned all the time be greater than the amount saved by reducing the friction?"

"Of course not; although the first cost of lining up will be greater than at any other time, you won't have to line up the shafting every day. About four times a year will be enough, because much of the machinery is light and wear on the shafting is not excessive."

What Is Saved

"Why, I know a big mill where the cost of lining shafting was about $500 and a saving of something like $1700 was pocketed annually over the cost of operating before the shafting was put in shape."

"Well, that sounds good and it may be as you say," rejoined Wood, who was dying hard; "but I don't see why shafting should require lining four times a year."

"The reason is because a building will settle, timber will warp and shrink, belts will pull sideways, up and down and at angles, and bearings will wear. There is no getting away from that."

"I guess those reasons will hold water. I believe that machine would come in handy for putting up countershafts, etc., as well," continued Wood, with a trace of warmth. "It wouldn't take long to train someone to use it, I suppose?"

"Humph; it will almost work itself. Any mechanic of ordinary intelligence can do the work. You could yourself," I added as a knock. "In fact, but two men are required to work the thing and the lining can be done in about one-fourth the time required with the old method. There is no bother with removing belts while doing the work, and it is a wonder to me that you don't buy one of these machines and be uptodate."

Wood mused for a time and then said: "How are you going to work where there are obstructions under the center of the shaft? There are several such lines in our mill."

Works Under All Conditions

"The easiest thing in the world, for in such a case a portable target can be attached to suitable rods so as to come free of the obstructions at one side. To tell the truth, I don't know of a condition under which the instrument cannot be used. Even brick walls are no barriers, as it is merely a case of drilling a small hole through in order to obtain a sight of the fixed target at the other end of the shaft.

"More than that, the level can be used to good advantage in putting up pipe lines, especially water pipes in which pockets are likely to form and freeze in cold weather, as the proper pitch can be obtained.

"In my opinion, you can't go wrong in getting one of these instruments, and the sooner the better, for, honestly, Wood, the way we are throwing away coal in overcoming useless friction would make the directors slice your salary if they knew it."

I had Wood on the run. He gave a feeble smile and said that he would look into the matter, adding it was just as important to look after the economical operation in the mill as it was in the power plant.

Wood Acts

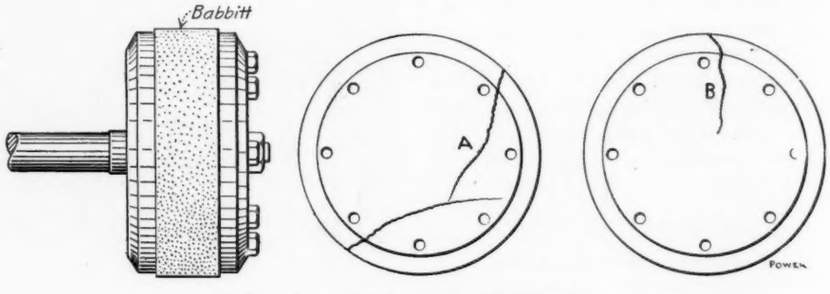
It wasn't many days before I noticed that the coal consumption was decreasing, and an investigation showed that Wood had purchased an engineer's level and was using it. I do not recollect the saving made by keeping the shafting aligned, but perhaps Wood's own words will give an accurate idea of the value of the device, for he said later, when speaking of its work: "No living man could have made me believe that those shaftings were so out of alignment, or that there was so much needless friction in the bearings."

Wood was game, however, and invited me to hand him another whenever I could. But I had more troubles of my own before I again caught him napping.

Emergency Piston Repair

The piston of a condenser air pump fractured when the condenser lost its vacuum and the pump ran away. The fracture in the 12-inch piston is shown at A and that in the follower head at *B*.

As this air pump must be kept going the engineer decided to try a babbitt piston. The rings, which were also fractured in the accident, were removed and the space between the front head of the piston and the follower plate was filled with babbitt, turned off to a smooth surface and of a diameter to fit the cylinder. The piston was placed in the cylinder, and the machine started up and was operated for three weeks before a new piston was secured.



How the Piston Was Repaired

Stone Boiler Setting

On the outskirts of the little town of Duryea, Penn., on the banks of a small stream, can be found an old dilapidated sawmill in which the belts are patched, the wheels run askew, the flooring is missing in places and the entire plant has the appearance of having seen its best days. The old mill is shown in Fig. 1, with its little 6-ft. waterwheel that furnishes power when there is enough water.

FIG. 1. OLD MILL WITH ITS 6-FT. WATERWHEEL

When the water is low, a 40-in. by 14-ft., return-tubular boiler and an old slide-valve engine are pressed into service. The boiler is a curiosity, inasmuch as there is no brickwork included in its foundation or setting. The setting is of stone, held together by mud or a certain kind of fireclay with which is mixed salt and wood ashes. The setting is shown in Fig. 2.

The boiler is fitted with a ball-and-lever safety valve, but the lever is loaded with two ordinary lever weights, and, although the owner of the place maintains that the boiler will blow off at 100 lb. pressure, the weights on the lever would suggest that this pressure is far below the actual blowing-off point.

In spite of the fact that the boiler is of uncertain age, a pressure of between 90 and 100 lb. is carried. The owner, insists that the shell is as strong as ever, but admits that the tubes are "a bit weak." Some day the neighborhood will probably be startled by a "mysterous" boiler explosion.

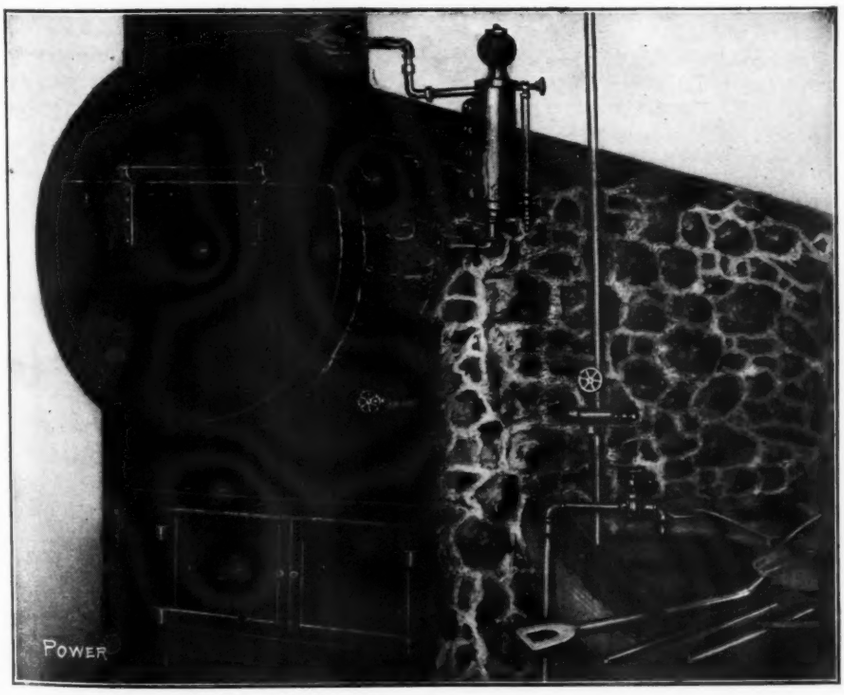


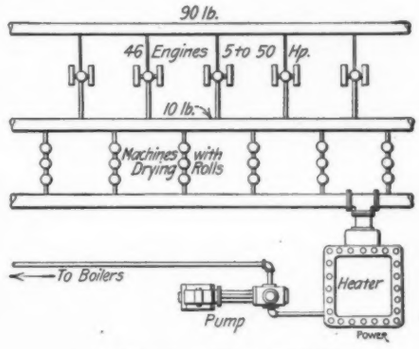
FIG. 2. STONE BOILER SETTING

Saving the Returns

Much of the loss obtaining in textile work is due to the waste of return condensation, sometimes to its contamination by dye stuff and more usually because proper provision has not been taken to pipe the returns to suitable apparatus for using it over again.

A notable instance can be found at the Garner Print Works, Garnerville, N. Y., wherein the chief engineer, Robert L. Sheraton, utilizes the condensed water coming from 50 small engines which are used throughout the plant. The steam for these engines is taken from a high-pressure main, and the exhausts of each are connected to a single exhaust-steam header.

In the process of manufacture, drying machines are used which require a large amount of steam in the drying drums. Steam for this purpose is taken from the main exhaust-steam line, and after passing through the several machines at a pressure of 10 lb., it is discharged into a second exhaust-steam main. It is then conveyed to a large open heater, and then pumped back to the boilers, without undue waste of steam from any of the auxiliary engines, except that which may occur due to piston-rod leakage, etc.



EXHAUST STEAM PIPING

Under former conditions, it was wondered why the returns coming to a certain heater were at such a low temperature, and one day it was accidentally discovered that the return pipe which runs underground was in the direct path of a cold-water discharge through which waste water passed to a creek, and this waste water was discharged directly upon the hot-water returns to the heater.

The elimination of this source of waste, and adding other improvements have enabled several boilers to be cut out of commission, with a corresponding decrease in fuel consumption.

Old Centennial Boilers

A part of the installation of steam boilers at the Dutchess works of the Garner Print Works, Wappinger Falls, N. Y., is a battery of an old type of boilers seldom seen on this side of the water, three of which have an interesting history. At this old boiler plant, which is about to be discontinued, there are 10 boilers, three of the Galloway type and seven drop-flue boilers.

The Galloway boilers were made by Galloway & Sons, Manchester, England, in 1876, and were brought over to this country and installed at the Philadelphia Centennial. When they had served their purpose they were removed to their present position and have been in use ever since, running at a pressure of 50 lb. per square inch.

The other boilers are what were commonly known as the drop-flue type, in that there are three flues attached to a header connection at both ends of the boiler and two flues through which the return gases pass to the stack. These boilers are fitted with gage-glasses and try cocks, but the Galloway boilers are equipped with the gage-glasses only, there being two on each boiler, one to be used in case the other gets out of order. These Centennial Galloway boilers are 7 ft. in diameter, 28 ft. long, and have two furnaces each 36 in. in diameter. They will soon be displaced by new, uptodate water-tube boilers.

On the main steam header, which extends over the top of the boilers, are several interesting expansion joints, one of which is shown in Fig. 2. They are made of wrought-iron disks, which are bolted together with suitable packing inserted between the two inside faces of the flanges. These expansion joints are fitted into the main steam header, which is constructed of cast iron.

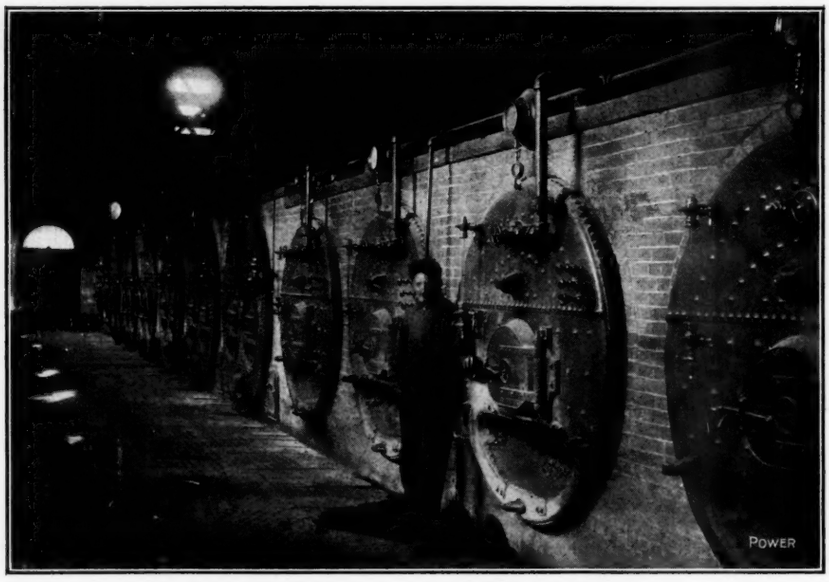
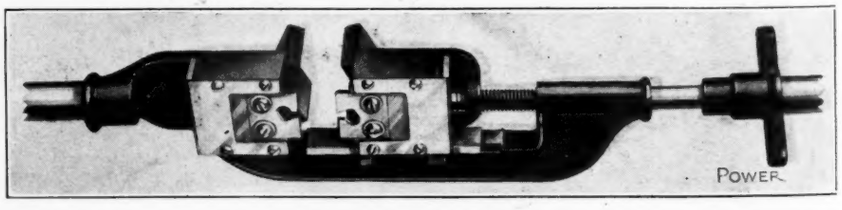


FIG. 1. OLD CENTENNIAL GALLOWAY BOILERS

FIG. 2. WROUGHT-IRON EXPANSION JOINT

Square End Pipe Cutter

This tool severs a pipe the same as a lathe tool cuts off a piece of bar metal. The knives are fed automatically and as they revolve cut a narrow slot around the pipe. The operator turns the tool by two handles similar to using a die stock. The knives make a square pipe end on which the threading dies will easily start. The tool does not split the pipe and saves the time necessary for reaming the inside of the pipe. The form of the knives regulates the depth of the cut. The tool is manufactured by the Borden Co., Warren, Ohio.

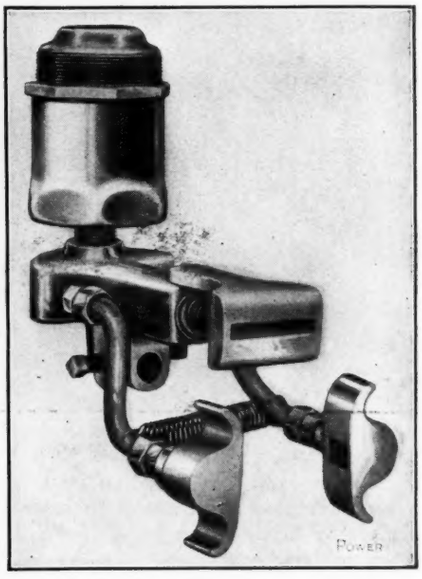


SQUARE END PIPE-CUTTING TOOL

Elevator Guide Lubricator

The "Economy" elevator guide lubricator is built in several sizes. The body is a hollow casting, to which is attached a compressed-air grease cup. An occasional turn of the top nut compresses the air confined in the cup sufficiently to force grease out through the arms of the lubricator to the side rails in a thin ribbon of grease where the guide shoes bear.

The distributors are kept against the face of the rail by springs. The device, illustrated herewith, is manufactured by the Peterson Engineering Co., 50 Church St., New York City.



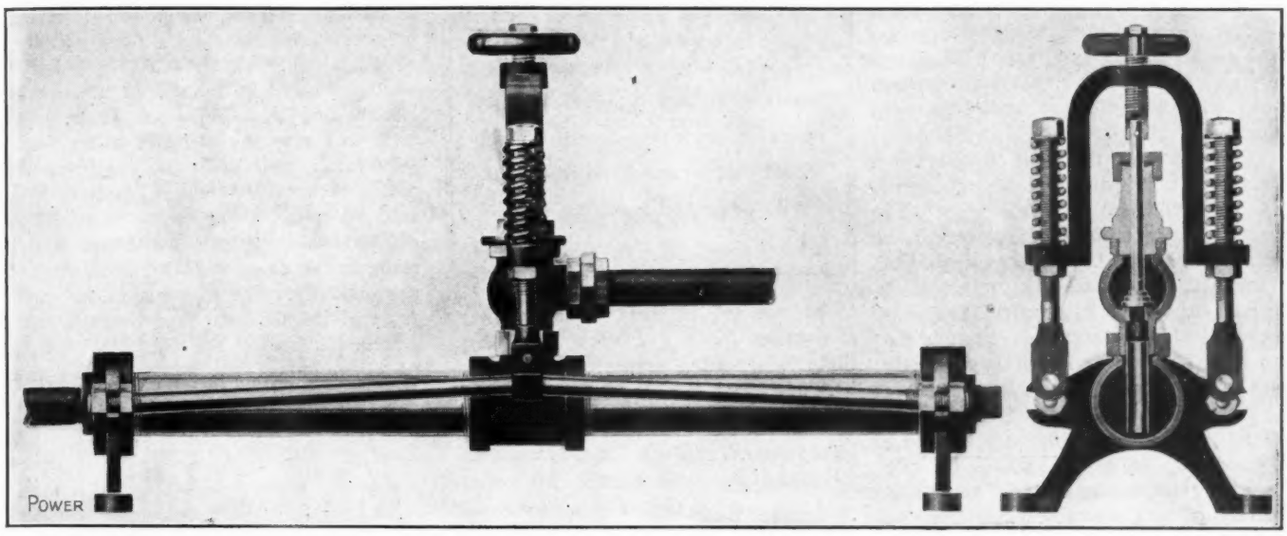
ELEVATOR GUIDE LUBRICATOR

Komo Steam Trap

The body of the trap consists of two tubes of a metal having a high coefficient of expansion. These are joined at the center by a T carrying the valve, and are screwed at their outer ends into castings carrying the lugs upon which the trap is set. Each of these castings has an internally threaded opening, one of which is used as the inlet to the trap and the other is plugged.

The end castings carry side lugs or brackets which are connected by the upwardly bowing side rod shown. As they are drawn together by the contraction of the receiving tubes, the side rods are buckled upward with a movement very considerably multiplied by reason of the toggle-joint action raising the valve through the connection shown in the engraving. The inner tube reaching nearly to the bottom of the trap seals it against the escape of steam, the entrance of which expands the receiving tube and closes the valve before all the water has escaped. The springs upon the rods connecting the side rods to the yoke hold the valve to its seat against the steam pressure and permit the trap to be adjusted to different pressures and temperatures; the handwheel at the top is used for blowing out or adjusting.

It is made by the Linton Machine Co., 26 Cortlandt St., New York City.



LONGITUDINAL AND SECTIONAL VIEW OF THE KOMO STEAM TRAP

Dourte Valveless Pump

The horizontal type of Dourte valveless pump shown in Fig. 1 is designed to handle very trashy matter, weeds, or other material being sheared off by the edges of the ports.

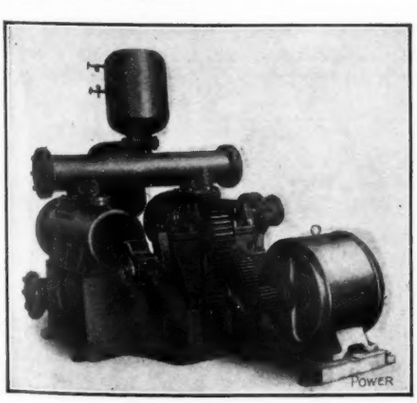


FIG. 1. DOURTE VALVELESS PUMP

The cross-section of one cylinder, Fig. 2, shows its design. A miter gear is keyed on the end of the crank and meshes with a similar gear on the end of the connecting-rod, which is connected to the piston by means of a universal coupling. When the crank revolves it pushes the piston back and forth and rotates it at the same time. The piston is of the trunk type, open at both ends, but has a partition in the middle. The head end has a port which alternately registers with the suction and the delivery ports. The delivery port is in a separate saddle which rides on the piston and is held down by adjustable springs.

In the pump shown, the suction port is cored out of the solid cylinder, but for service where the wear is great, the suction port is cast in a separate saddle which can be easily renewed when worn.

In the illustration, all ports are blanked, but as soon as the pump starts the suction port will begin to open. When the crank is at 90 deg. from the position, the piston port will be exactly over the suction port. If on the dead center and opposite the present position, the ports will all be blanked again. When the crank is straight down, the piston port will be exactly under the delivery port. If the pump is reversed or the piston is set at 180 deg. from its present setting, it will pump from the delivery to the suction; in other words, the flow will be reversed.

This pump is manufactured by the Dourte Valveless Pump Co., Longmont, Colo.

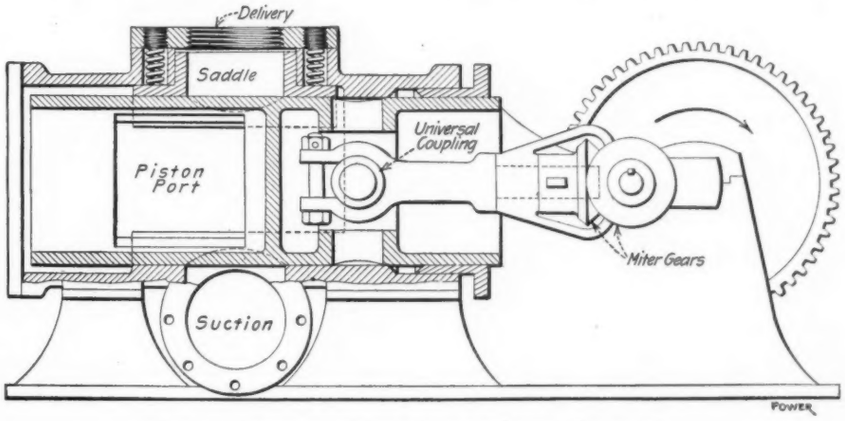


FIG. 2. SECTION THROUGH THE WATER CYLINDER

Wood in Pulleys

Wood is used in many places where it was not thought of before. It was perhaps the split idea that first made the wood pulley popular, and that idea is freely used in metal as well as wood pulleys. But now one finds many wood pulleys where there is but little call for the split. A sample instance is on motors for driving machines. When dynamos and motors were new, wood pulleys were not a part of them; now they are an important part wherever belting is used. There are places where the metal pulley is essential, and will always be used, but where it is not absolutely necessary the wood pulley seems to be getting the call right along.—*The Wood Worker.*

Homemade Automatic Engine Stop

By C. A. Ware

Description of the construction and action of an electrically operated automatic engine stop which can be made in any ordinarily equipped machine shop.

With comparatively simple facilities at hand an automatic engine stop can be made which in the present case was applied to eight 42 and 86 by 60-in. vertical engines, direct-connected to alternators. The stop is electrically operated; a layout of the circuit for one engine is shown in Fig. 1.

The small governor *G* is driven from the tail shaft of the engine; its speed bearing a constant ratio to that of the engine. In case the engine overspeeds the governor balls move outward, due to centrifugal force, and the contact *D* is drawn over until it touches the two contacts and closes the circuit through the trip coil *C* (Fig. 2) which immediately attracts its plunger *P* and by means of the lever shown rotates the hook *H* to the left, after which the arm *A*, being unsupported, is pulled down by the weight *W*, closing the butterfly valve and shutting off the steam. When the arm *A* swings downward the small switch *S*, shown mounted on the upper side of the arm, moves away from the two spring contacts which it normally touches while

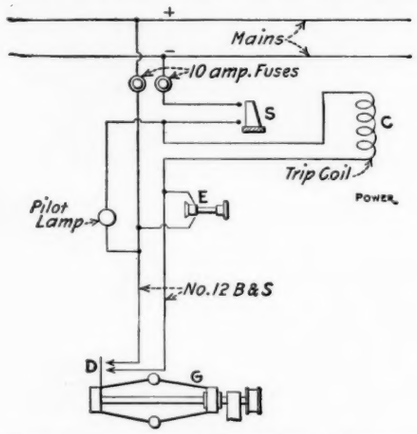


FIG. 1. LAYOUT OF ELECTRICAL CIRCUIT

A is held up and the valve is open. As soon as the switch leaves the contacts the current is interrupted at this point to prevent arcing; as the engine slows down the governor contact *D* is gradually moved away from its contacts.

When the hook *H* trips, the arm *B*, connecting with the pull rod as shown in Fig. 2, moves downward, and to avoid any opposing force the head of the pull rod should be slotted, allowing the pin in the arm to move freely downward.

Referring to Fig. 1, the wires can be connected by means of a double-pole, double-throw switch either to the direct-current exciter busbars, or to the storage battery, each of 110 volts. The pilot lamp and the cutout switch *E* are mounted on a column close to the throttle valve.

When starting up and when shutting down the engine, the switch *E* is pulled to operate the butterfly valve and keep it working freely and show that everything is operating properly. As a number of these cutout switches may be located anywhere about the building, the pilot lamp should always be lighted as it gives a visual indication by going out if any failure of the current occurs. By making the connections as shown in Fig. 1, any failure of the switch *S* to make contact would also cause the pilot lamp to go out.

All supporting brackets, levers, links, etc., used in this device were made in a machine and blacksmith shop having only ordinary equipment. The contacts of the switch *S* were made of two pieces of thin phosphor bronze, as this material retains its elasticity. These contacts and also the piece of sheet brass in contact with them are mounted on pieces of hard fiber which insulate them from the supporting metal parts. The coil *C* and its frame, while not homemade in this case, could be made without any difficulty. The frame could be made from ½-in. flat iron bent U-shape with a flat piece to close the end. Care should be taken to get the joints as true and close fitting as possible.

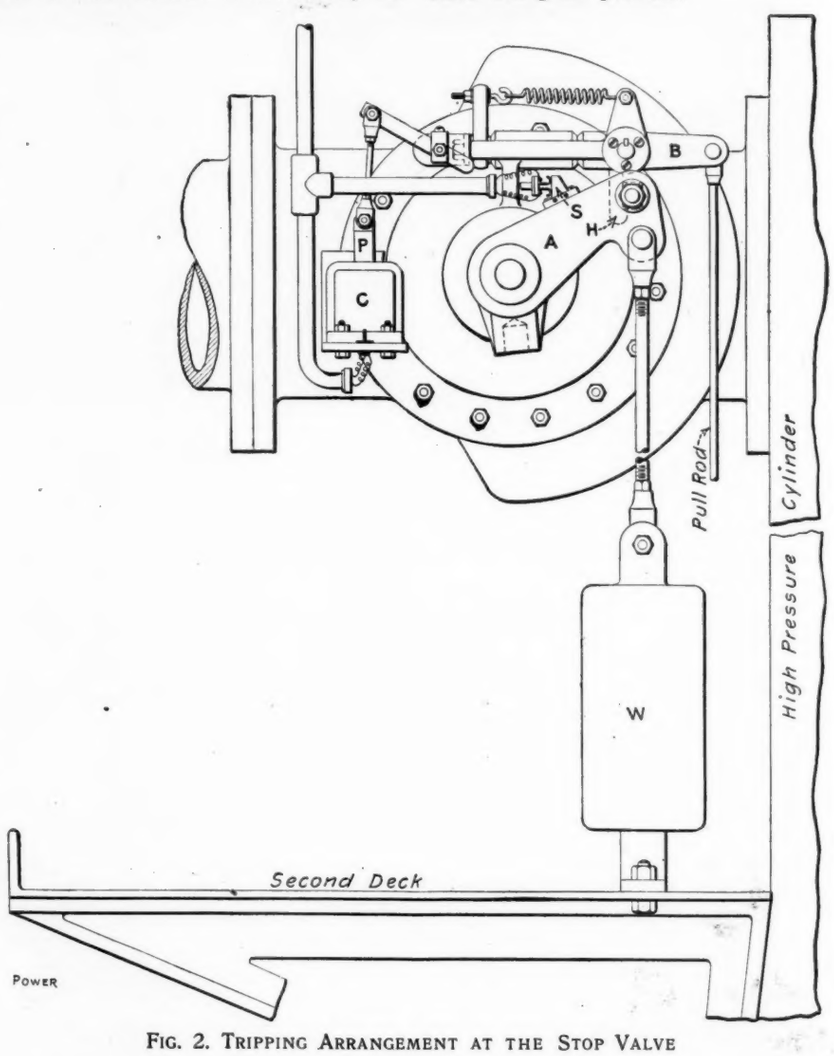


FIG. 2. TRIPPING ARRANGEMENT AT THE STOP VALVE

The coil, about 4 in. long, can be made by winding with 2 lb. of No. 22 B. & S. gage magnet wire (this amount for 110 volts). The plunger *P* is 1¼ in. in diameter and is 3 in. long. A brass sleeve is put inside the coil and extends up flush with the surface of the iron frame. This prevents the plunger from

sticking to the frame, as it would do if there were actual contact between the two; the sleeve also protects the inside of the coil. A soft steel plug should be fitted to the lower end of the magnet frame and extend up through the coil for about 1 in. to provide a stop for the plunger. A thin disk of brass or copper should be fastened to the upper end of the plug to prevent actual contact with the plunger and the sticking together which would result.

The circuits are wired with No. 12 B. & S. wire in ¾-in. loricated conduit. The governor was purchased from a firm making a specialty of manufacturing them for this purpose.

BOOKS RECEIVED

FARM GAS ENGINES. By H. R. Brate. The Gas Engine Publishing Co., Cincinnati, Ohio. Cloth; 195 pages, 5x7 in.; illustrated; indexed. Price, $1.

BUILDING AND FLYING AN AEROPLANE. By Chas. B. Hayward. American School of Correspondence, Chicago, Ill. Cloth; 142 pages, 5½x8½ in.; 52 illustrations; tables; indexed. Price, $1.

NEW PUBLICATIONS

PERKINS TABLES, for use in Calculations for safe working pressure on boilers. By Lyman B. Perkins. 360 pages, 5x7⅛ in., thin paper, flexible leather covers. Published by the author at 38 Huntington St., Hartford, Conn. Price, $5.

The author, a graduate of Annapolis, has been employed for over 25 years by the Hartford Steam Boiler Inspection & Insurance Co., and much of this time has been occupied in making calculations relating to the strength of boilers. The tables are the outcome of the demands and developments of this experience.

The volume starts with a table of the bursting pressure of the hollow cylinder without a joint, and covers shells from 26 to 96 in. in diameter, from ¼ to ¾ in. thick and having tensile strengths from 45,000 to 62,000 lb. There are 11 pages of this table. The bursting pressures there given must be multiplied by the joint efficiency to get the bursting pressure, and most of the book is devoted to joint efficiencies. In this table can be found the efficiency of any practicable joint, and special tables are given for the conditions imposed by the Massachusetts Board of Boiler Rules. In addition are tables of head bracing, of segmental areas, collapsing pressures of furnaces and flues, directions for reinforcing openings, staying flat surfaces, sizes of pipe and boiler tubes, decimal equivalents, etc., and many useful formulas.

In its preparation Mr. Perkins has done a stupendous amount of work which, having been once thus reliably done, will not need to be done over and over again by boiler designers and inspectors who have access to this volume.

CENTRAL STATION HEATING. By Byron T. Gifford. Heating & Ventilating Magazine Co., New York City. Leather; 208 pages, 5½x9 in.; illustrated, numerous tables. Price, $4.

This book sets forth the advantages of central-station heating and is written from the standpoint of one interested in furthering this line of work. The chapters on rates, pipe-line construction, business management and franchises are excellent and have undoubtedly been drawn from the extended experience of the author. The data on radiation losses for different classes of conduit and insulation for street mains under varying conditions are also commendable. The factors are so given that the radiation losses for the various methods of insulation can be readily determined with fair accuracy.

The book is of doubtful value to designers of central heating plants wishing more than approximation, excepting the portion devoted to pipe-line construction. This is due to using arbitrary constants which, although excellent for the author's practice, might lead others to err when designing for different conditions.

The curves on pipe sizes combine all factors and allowances involved in the drop in temperature and loss of friction head. This makes them inadvisable for general use unless the complete formulas and factors are known. As nearly as the reviewer can check the curves for water, the friction heads are low. For a 20-deg. drop with a given output and drop in friction head, other authors give a discharge that would make the drop 26 deg. for the same size of main.

The author intimates that considerable difficulty has arisen from deterioration of mains, and mentions the use of comminglers and the furnishing of domestic water supply. It is poor practice to draw domestic water from heating mains, for the air contained in the make-up water tends to cause rapid deterioration. Comminglers would facilitate the removal of the air but might not wholly obviate the trouble.

It is stated that the friction of the moving water in the mains develops heat, thus returning some of the mechanical energy used in circulation. Also that heat is lost at the station, due to the increased pressure on the mains necessary to circulate the medium. If the exhaust of the pump is utilized in heating the water it is hard to see how increased pressure head on the system at the station would cause any particular loss on the water system other than that due to the steam efficiency of the pumping apparatus. This might be true on a steam system inasmuch as an increase in pressure is accompanied by a corresponding rise in temperature. Increased pumpage causes lower average temperatures of the circulated water, increased heat transmission through the heater and radiating surface and less drop on the system, all of which are advantages.

In considering the losses of water mains the radiation losses are calculated properly, but the constant 0.046 for cost of pumping is variable, depending on the steam consumption of the prime mover, which in this case would be about 60 lb. per horsepower-hour. The amount of heat returned to the main should be figured with the mechanical equivalent of heat in each case and the steam consumption of the prime mover determined and the heat developed from friction deducted. At 26 lb. of steam per horsepower-hour the loss in the pump will just balance the heat returned from friction. Any higher steam consumption requires an addition to the losses in mains. This will show high velocities and small mains to be advantageous.

The pipe-line design for hot-water systems should be arranged so that the distance will be balanced as well as the friction heads on the different circuits, thus doing away with individual regulation of outlets and the use of choke valves. It makes automatic heat control unnecessary and enables all sections to be regulated by the change in water temperature and vacuum at the central power house.

An arrangement of mains is shown that would require more or less throttling in spite of the best hydraulic calculations unless very low velocities and large mains were used. By making the supply and return flow in the same direction this difficulty is avoided for all velocities and the increased cost would be insignificant compared with the advantage gained.

The author considers that a surface condenser or closed heater cannot be made to condense all the steam with the same facility as a barometric condenser and an open heater. This is not true for a closed water system which can be operated under vacuum equally well with a barometric or surface condenser. The water to condense the excess steam passes through the condenser proper and should be kept out of the heating system. Its temperature can be regulated exactly by the degree of vacuum, the temperature of the outboard water of the heating system approaching that of the vacuum within 2 or 3 deg. in a properly designed plant. This requires large pumpage, high velocities and small drop in temperature to be successful.

When the heating system is used solely as a condenser the degree of vacuum is merely incidental and interferes with the regulation of the heating temperature as the water becomes overheated and at the same time the vacuum is reduced.

Hot-water boilers are given attention, and, although used in some plants, they are not as easily regulated as high-pressure steam boilers and a live-steam heater. In a by-

product plant the hot-water boilers would be an unnecessary investment, to say nothing of being idle in summer. It is this unnecessary investment in boilers that makes the central heating plant so attractive in connection with the central power plant.

In the discussion of some chapters to the exclusion of others it has not been the intention to detract from the excellent matter contained therein, but rather to call attention to some of the points differing from the practice of the reviewer. As before stated, the subject has been approached more from a business than an engineering standpoint, and this addition to the limited literature on the subject should succeed in its mission of awakening station managers to the advantages of the combined central heating and power plant.

Universal Craftsmen's Convention at St. Louis

On June 6 to 9 the tenth annual convention of the Universal Craftsmen Council of Engineers was held at St. Louis, Mo.

The entire second floor of the Planters' Hotel was engaged by the convention and tastefully decorated. The exhibitors' booths were in the dining room, and the delegates met in the large reception hall, adjoining which were the meeting rooms of the national secretary and treasurer and executive committee. The convenience of these arrangements reflects great credit upon the local committee, and particularly on Chairman Samuel J. Hunt.

There were 137 delegates in attendance, and considerable important business was transacted. A charter was granted to the German engineers of Greater New York, and a new council will be formed in which the work will be carried out in German. The financial condition of the organization was reported to be first-class.

The opening exercises of the convention took place on Tuesday morning. Chairman Edwin S. Hallett introduced the Rev. Brother Early, who pronounced the invocation. The address of welcome was made by Samuel J. Hunt. Walter J. Cadwell, past grand worthy chief, responded, after which an address was given by Grand Worthy Chief Thomas H. Jones. After the announcement the committees were appointed, and the meeting adjourned.

On Tuesday afternoon the visitors, in automobiles, visited Art Hill and the museum where the official photograph was taken. In the evening the ladies went to the Demar Gardens.

On Wednesday afternoon the delegates made a tour of the Anheuser-Busch Brewery, and in the evening were the guests of the Steam Engineers Club of St. Louis. In the evening the ladies were entertained at Forest Park Highlands.

DELEGATES AT THE MEETING OF THE UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS, ST. LOUIS

On Thursday afternoon the company enjoyed an excursion on the Mississippi and in the evening a vaudeville entertainment in the convention hall at the hotel.

During the convention, Mrs. O. N. Pomeroy was presented a cut-glass set, Mrs. Thomas H. Jones a silver service, and Worthy Chief Thomas H. Jones a past chief's jewel.

The election of grand officers resulted as follows: James U. Bunce, worthy chief; H. C. Senn, assistant worthy chief; William Armstrong, secretary; N. J. Burdick, treasurer; William J. Weyker, warden; Charles F. Siegrist, guard; P. H. Early, chaplain; H. E. Terry, chairman of the board of trustees; Samuel J. Hunt, trustee; F. W. Townsend, trustee.

Boston, Mass., was selected for the 1913 convention.

Exhibitors

Garlock Packing Co., Jenkins Bros., Dearborn Drug & Chemical Works, Reeves, Skinner Machinery Co., Lunkenheimer Co., POWER, John E. Angell & Co., Armstrong Cork Co., Keystone Lubricating Co., Capen Rubber & Belting Co., Schaeffer & Budenberg Manufacturing Co., V. D. Anderson Co., Triumph Ice Machine Co., Western Valve Co., Lagonda Manufacturing Co., Walter L. Flower Co., Wagner Electric Co., A. Leschen & Sons Rope Co., Frank Adams Electric Co., C. E. Squires Co., Broderick & Bascom Rope Co., M. H. Foundry & Manufacturing Co., Elliott Co., Diesel Engine Co., McLeod & Henry Co., International Acheson Graphite Co., George T. Mathews & Co., William Kemp, Arrow Boiler Compound Co., Indestructible Fan Blade Co., H. W. Johns-Manville Co., Bogardus Co., Price Hill, Heine Safety Boiler Co., F. C. Lemire, Liberty Manufacturing Co., Mound City Oil & Supply Co., J. Brockman Manufacturing Co., L. M. Sperry, A. S. Doxey, Ohio Injector Co., Hahn & Mayer.

Illuminating Engineers' Convention Program

At the sixth annual convention of the Illuminating Engineering Society, at Niagara Falls, Ontario, Sept. 16 to 19, a report will be presented dealing with recent progress and developments in the lighting industry both in this country and abroad.

The committee on nomenclature and standards will present a report dealing with certain definitions and terminology of illuminating engineering. "Steel Mill Lighting" will be the title of a report by C. J. Mundo, chairman of the committee on illumination of the Association of Iron and Steel Electrical Engineers.

F. W. Goodenough, chairman of the council of the (British) Illuminating En-

gineering Society, will read a paper, "High-Pressure Gas Lighting." The program as thus far arranged includes the following papers: "The Status of High-Pressure Gas Lighting," George S. Barrows; "Recent Developments in Gas Lighting," R. F. Pierce; "Indirect and Semi-Indirect Illumination," T. W. Rolph; "Recent Developments in Series Street Lighting," C. P. Steinmetz; "Research Methods," E. P. Hyde; "The Problem of Heterochromatic Photometry and a Rational Standard of Light," H. E. Ives; "Reflection from Colored Surfaces," Claude W. Jordan; "Diffuse Reflection," P. G. Nutting; "A Study of Natural and Artificial Light Distribution in Interiors," M. Luckiesh; "The Physiology of Vision," T. A. Woodruff; "The Efficiency of the Eye Under Different Systems of Illumination," C. E. Ferree (this paper will be a report of a research carried on for the American Medical Association); "A Proposed Method of Determining the Diffusion of Translucent Media," E. L. Elliott; "Illumination Charts," F. A. Beuford; "The Determination of Illumination Efficiency," E. L. Elliott; "An Absolute Reflectometer," P. G. Nutting; "Colored Values of Illuminated Surfaces," Bassett Jones, Jr.; (this subject will be presented in the form of a series of experimental demonstrations).

One session is to be devoted to discussing miscellaneous phases of illuminating engineering, to bring forward certain features not covered by the formal convention papers.

Kelvin Memorial Window

It is proposed by the engineering societies of Great Britain and the United States that a memorial window to the late Lord Kelvin (Sir William Thomson) be erected in Westminster Abbey.

American engineers are invited to contribute to this tribute of respect to the foremost scientist of his day and an engineer distinguished in his application of scientific knowledge to enterprises of world-wide importance. Individual subscriptions need not exceed $10, but those who wish may increase their contribution.

Coutts & Co., 40 Strand, London, W. C., are the treasurers of the fund.

Hot Bearing Stops Trial

A hot truss-bearing on the port shaft of the torpedo-boat destroyer "Henley" halted its standardization trial on July 20. The destroyer had been over the course off Rockland, Maine, 21 times when the mishap occurred, making the runs at speeds ranging from 12 to 29 knots an hour. The last mile was made in 2 min. 4 sec., which would give about the contract speed of 29½ knots.

Halfway down the course on the last of the top-speed runs one of the truss-bearings was seen to be smoking, and the ship was immediately headed for Rockland. In all other respects the destroyer made a fine showing.

Flywheel Explodes in Flouring Mill

A flywheel explosion occurred at the Hull & Draper flour mill, Salem, Ill., July 16, a few minutes before shutting-down time. The engine was an old slide valve fitted with a throttling governor. The explosion was caused by excessive speed due to the governor belt breaking. The wheel was about 10 ft. in diameter and ran at a normal speed of 75 r.p.m. The broken spokes and rim showed flaws in the metal. One piece of the wheel weighing about 800 lb. was thrown about 400 ft. The hub remained on the shaft with the spokes broken off close.

The engineer was not in the engine room at the time of the explosion. He did the firing and helped in the mill, receiving a wage of $6 per week.

Minneapolis Electric Co. Under New Management

Active management of the Minneapolis General Electric Co., which was purchased from Stone & Webster some time ago, was assumed, Aug. 1, by H. M. Byllesby & Co. Vice-President Arthur S. Huey personally superintended the transfer. Gen. George H. Harries, for some time president of the Louisville Gas Co. and vice-president of the Consumers Power Co. and of the Minneapolis General Electric Co., has been assigned general supervision over the property. Samuel Kahn took charge as acting manager to serve temporarily or until a permanent manager is appointed. Mr. Huey announced that the company would proceed to develop 35,000 hydro-electric horsepower on the St. Croix River above the present 20,000-hp. development at Taylor's Falls. He stated also that the company contemplates further water-power development on the Mississippi River amounting to approximately 80,000 hp., which would give a total of not less than 160,000 hydro-electric horsepower, including several smaller developments, available to Minneapolis and St. Paul and vicinity. The properties at Minneapolis and St. Paul will be connected by transmission lines to the water powers of the Consumers Power Co., at Cannon Falls, and Mankato also will be tied in by a transmission line running south from St. Paul.

Dartmouth (Eng.) to Honor Newcomen

Desirous of honoring the memory of Thomas Newcomen, who first worked out the idea of a piston in his atmospheric engine, the pioneer of the present locomotive and stationary steam engines, the citizens of Dartmouth, England, propose to establish in his honor a museum in that town. If the funds collected prove insufficient to maintain a museum, an obelisk is suggested.

Many prominent Englishmen are in sympathy with the project and have subscribed liberally.

Cotton Manufacturers Meet

The semiannual meeting, No. 93, of the National Association of Cotton Manufacturers, will be held at the Hotel Griswold, New London, Conn., Sept. 9 to 11, 1912, Governor Baldwin will deliver the address of welcome.

The most important papers to be presented are: "Cotton Growing in India," "Cotton Shipments and Reclamations," "Dust-proof and Water-proof Mill Flooring," "Economic Use of Lubricating Oils," "Humidifiers," "International Tariff Relations," "Lithographic Method of Cotton Printing," "Present Day Relations between the Foreign-born Operative and the Mill Management," "Raising Cotton in California," "Reports of Committees," "Selection of Sites of Cotton Mills," "Spinning Values of Different Grades of Cotton," "Tape Driving for Spindles," "Wastes in the Cotton Manufacture," "Workmen's Compensation Laws in the United States."

SOCIETY NOTE

During the summer months, every Tuesday evening at the Modern Science Club, Brooklyn, will be a social event.

PERSONAL

James T. Whittlesey, chief engineer of the Public Service Electric Co., Newark, N. J., has resigned to engage in consulting practice in San Francisco, Calif.

R. L. Brunet, industrial engineer of the Public Service Electric Co., Newark, N. J., has been appointed electrical and gas engineer of the department of public works, Providence, R. I.

D. D. Kimball, 15 West Thirty-ninth St., New York City, has been appointed to represent the American Society of Heating and Ventilating Engineers as chairman of the Section on Ventilation of the Department of Industrial Hygiene and Sanitation of the American Museum of Safety, 29 West Thirty-ninth St., New York, N. Y.

Moments with the Ad. Editor

F. A. Shoemaker, M. E., of Buffalo makes a specialty of designing power, light and heating plants.

Where one engineer deals with a single problem, he deals with a hundred of them.

Naturally he gets a broad outlook on the whole question of power-plant installation and maintenance.

And if he, who may be considered "authority" on the question, gets from Power's Selling Section the real value and help that he does, does it not follow that *you* will find there the answers to many questions that confront you?

This is worth reflection on your part and so is Mr. Shoemaker's letter which follows:

In reference to your article "Is there Anything *Not* Advertised In Power That *Ought* To Be?" I beg to state that as I have made a business of power plants as a Mechanical Engineer for a great many years and at all times have read POWER with a great deal of interest, I assure you that I do know of a great many things that *are* advertised in POWER that ought to be, and no doubt a number of things that are *not* advertised that should be.

One thing that I can say that may cheer you up some is the fact that I very seldom dictate a specification for a power plant or heating plant but what I refer to the advertisements in POWER for a number of articles I wish to use, as I am very busy and can more quickly find the address of the manufacturers by referring to the advertisement in POWER than to wade through cabinets of catalogues even though I keep those catalogues filed in perfect order and strictly classified. In this way POWER has been of a great benefit to me, also from practical experience with the merit of a very large number of appliances in the make-up of a power plant, I find the live ones and good ones avail themselves of the opportunities offered in your advertising pages.

There may be a large number of very good articles that a person or company have not been putting on the market very long who feel they can not stand the cost of high class advertising, and still another class of manufacturers who think they have been in existence so long that they do not have to advertise, but my experience as a power plant designing engineer has conclusively proven to me that both of these classes of people are missing a great many sales by not keeping their goods before the public. I know of several manufacturers who do not even have a man on the road who have built up enormous businesses and made large profits within the last fifteen years by carefully selecting high class advertising, and I cannot see how any manufacturer with a good article can expect to reach the largest number of customers interested in power plants without advertising in POWER.

A very large part of orders placed through my specifications every month have been such things as I have taken note of in your advertising spaces, and descriptive matter in the body of your magazine.

I feel that I can congratulate you as well as myself on your comprehensive advertising and the benefits I have derived from the same.

* * *

After all is said and done, the man who consistently reads Power advertising and buys advertised goods is going at his work along the right lines—

He's buying on a satisfaction-assured basis.